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Hillenbrand, II et al.

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(54) **PATIENT REPOSITIONING SYSTEM**

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USPC **5/81.1 HS, 81.1 C, 81.1 RP, 81.1 R**
See application file for complete search history.

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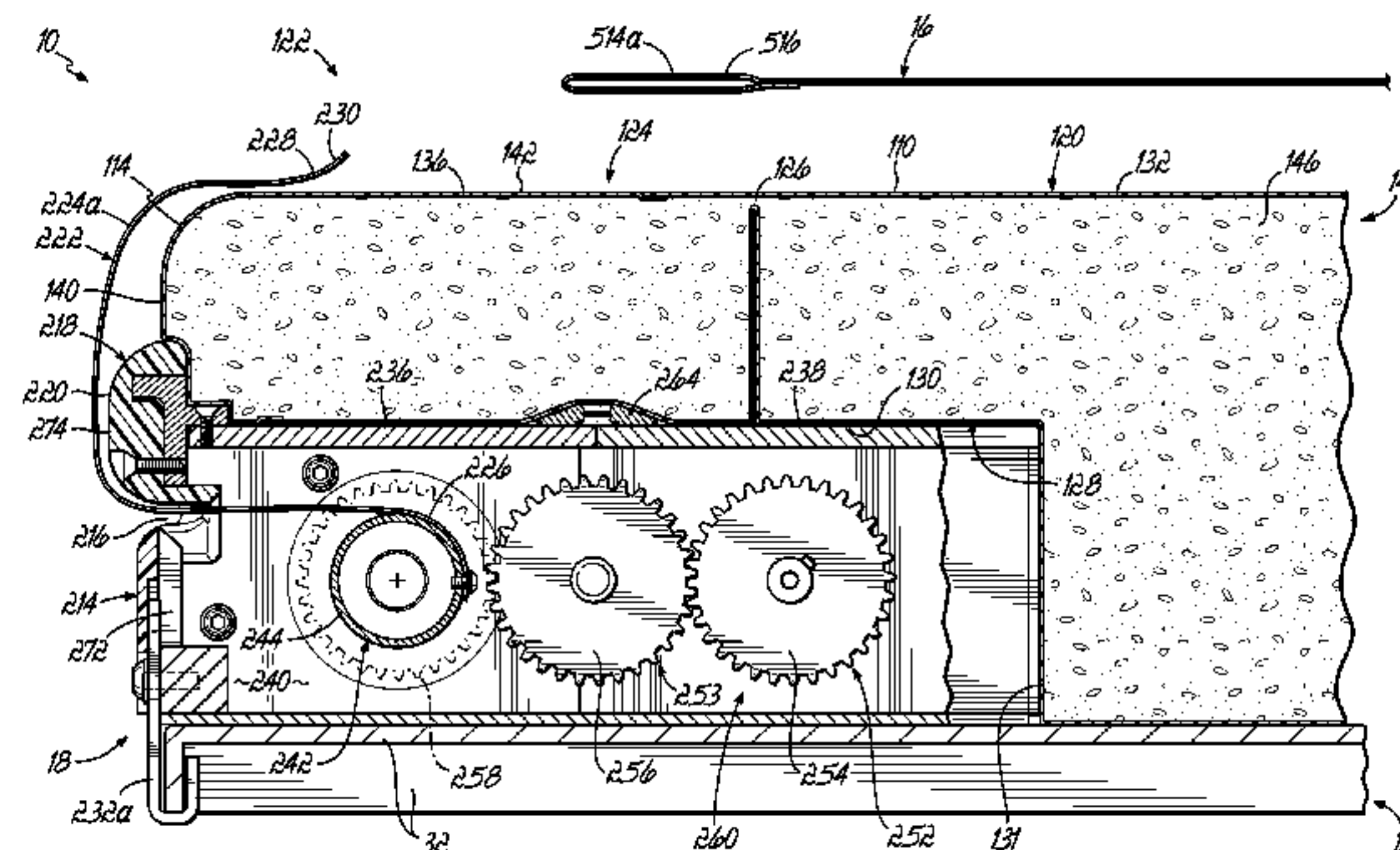
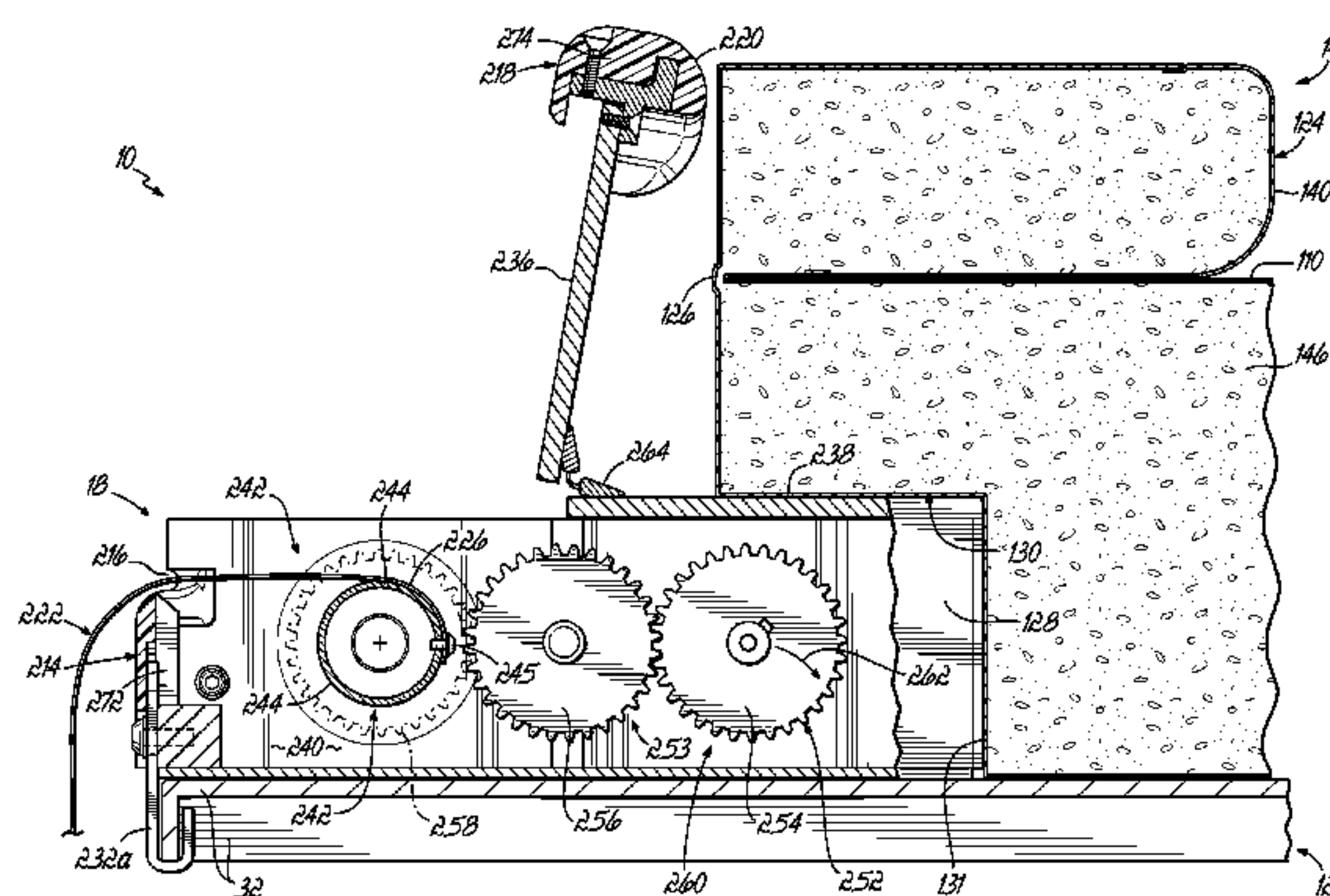
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(57) **ABSTRACT**

A patient repositioning system for pulling a patient toward a head end of a bed includes a sheet, a mattress, and a housing which contains at least a part of a drive mechanism for operatively coupling to and pulling the sheet. The housing resides below a head end piece of the mattress, and is secured to the bed deck. The sheet pulling structure extends out of the housing via a slot and releasably attaches to the sheet, in a manner which has a low profile so as to pass through the slot. The sheet is longer than and wider than the mattress, and has beaded longitudinal side edges which are retained within rows of spaced retainers located on opposite sides of the mattress. During pulling of the sheet, the contoured shape of the housing facilitates movement of the sheet into the housing via the slot, even though the sheet width extends beyond the lateral edges of the mattress. The sheet may include indicia for indicating a “loaded” condition, and also usage indicia to indicate that it is time for a new sheet to be used.

62 Claims, 26 Drawing Sheets



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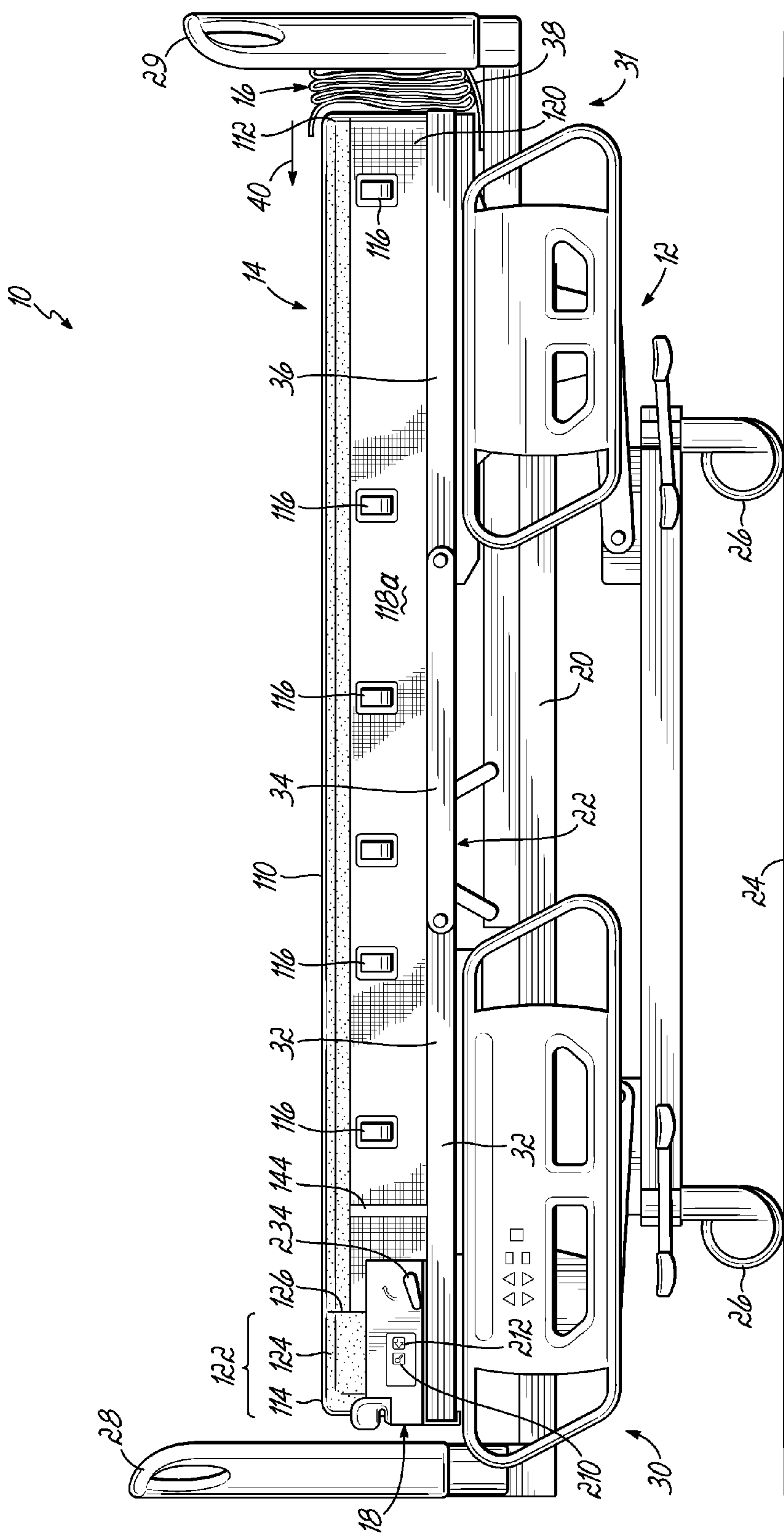


FIG. 1A

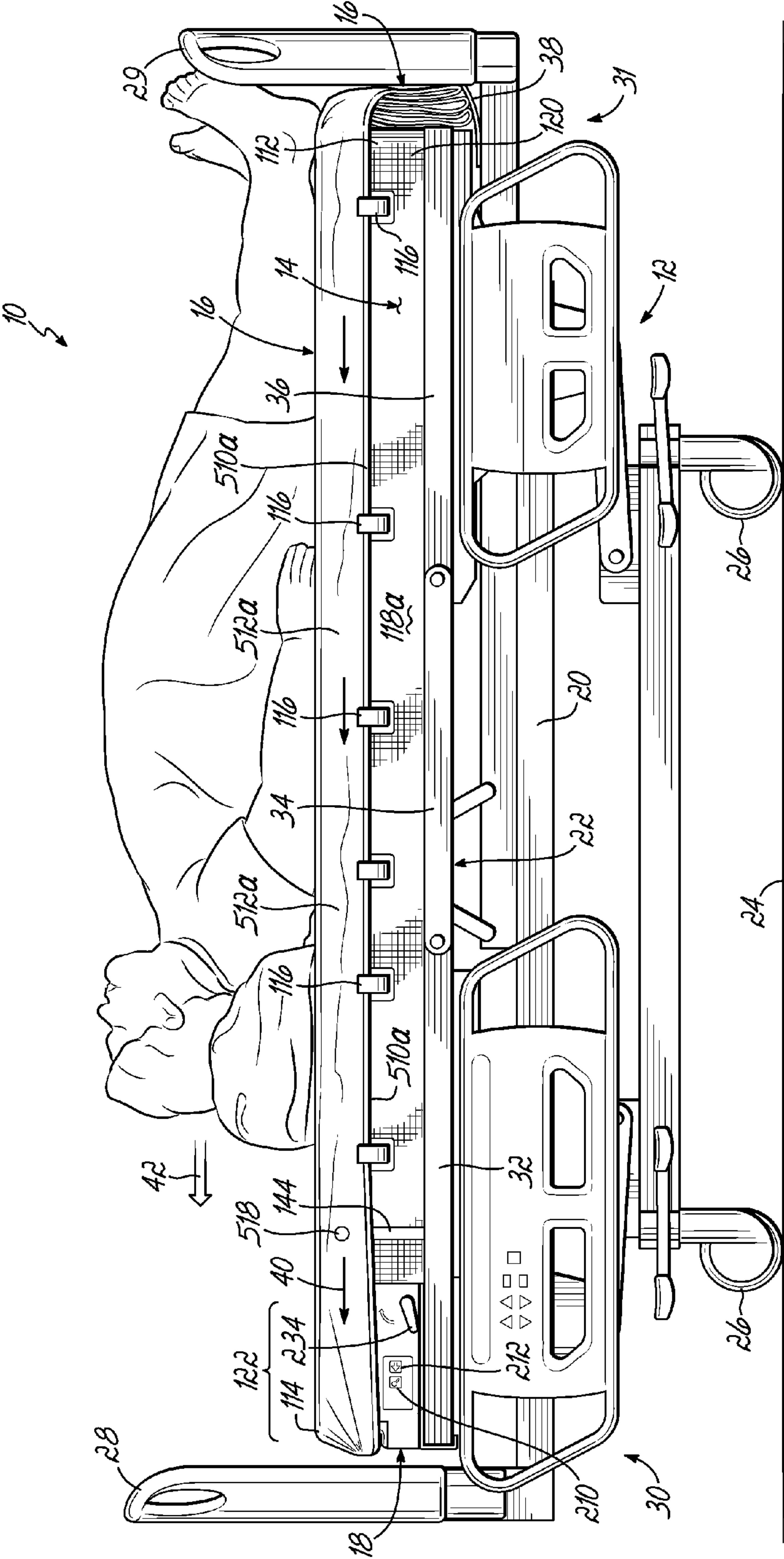


FIG. 1B

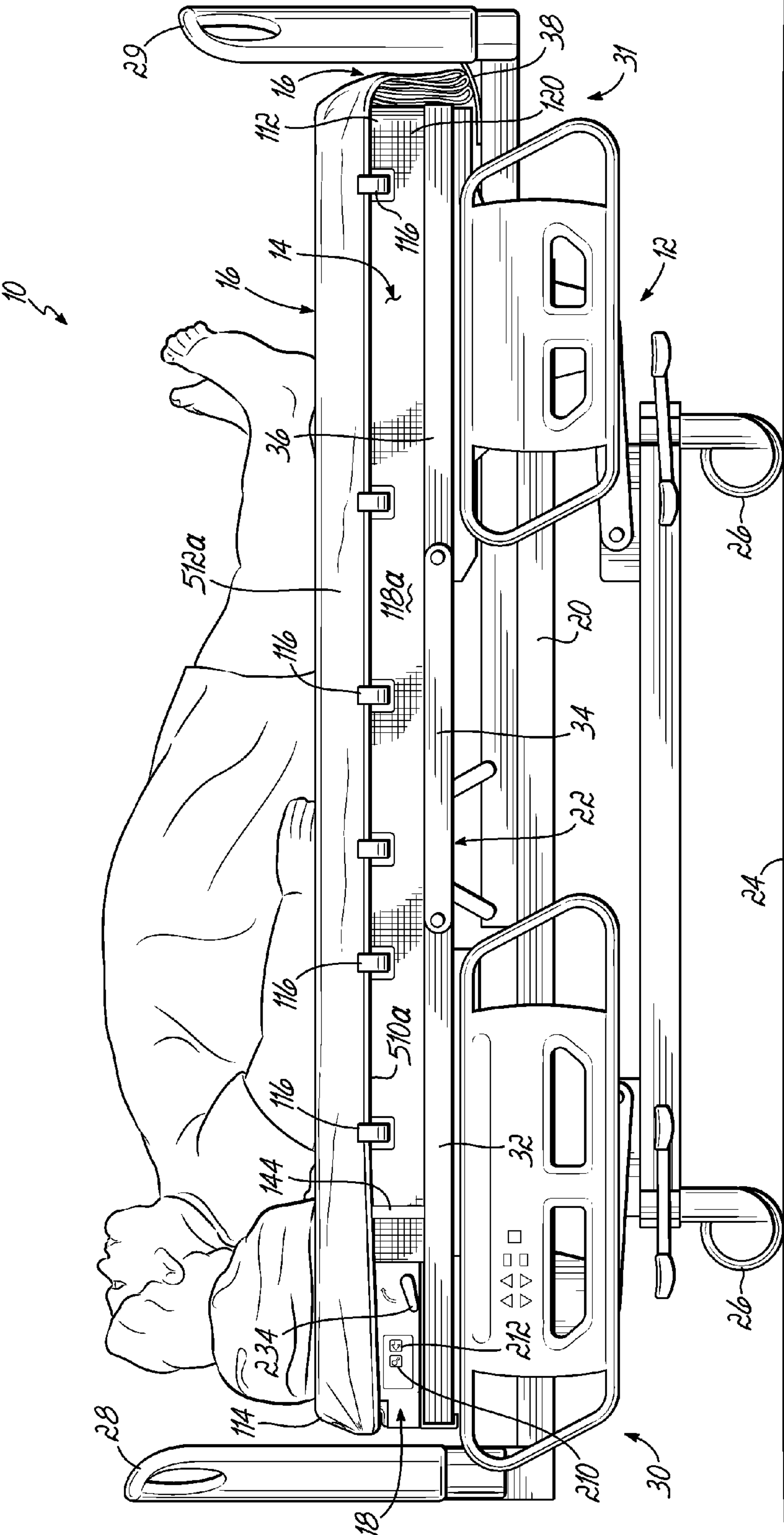


FIG. 1C

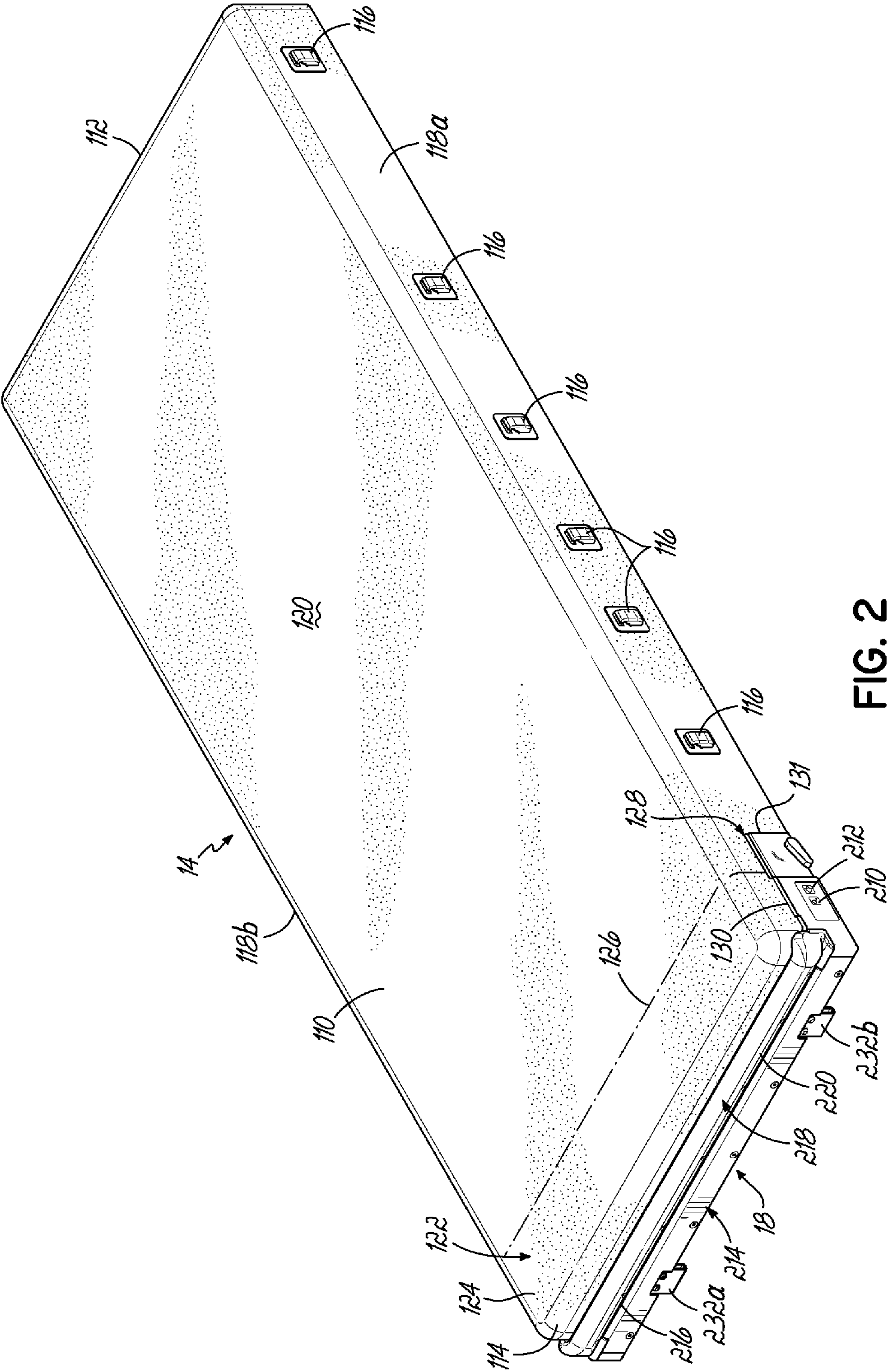


FIG. 2

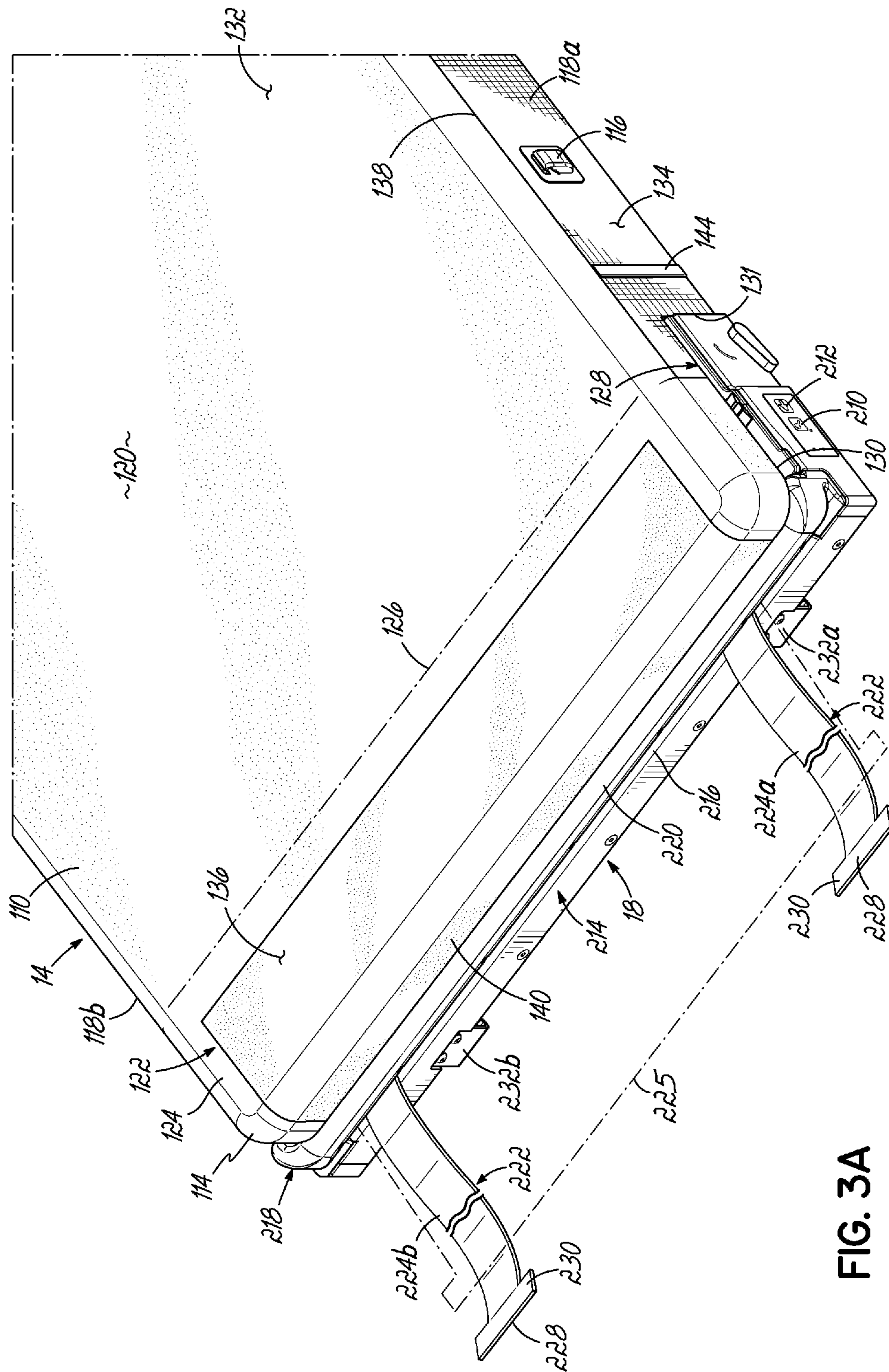


FIG. 3A

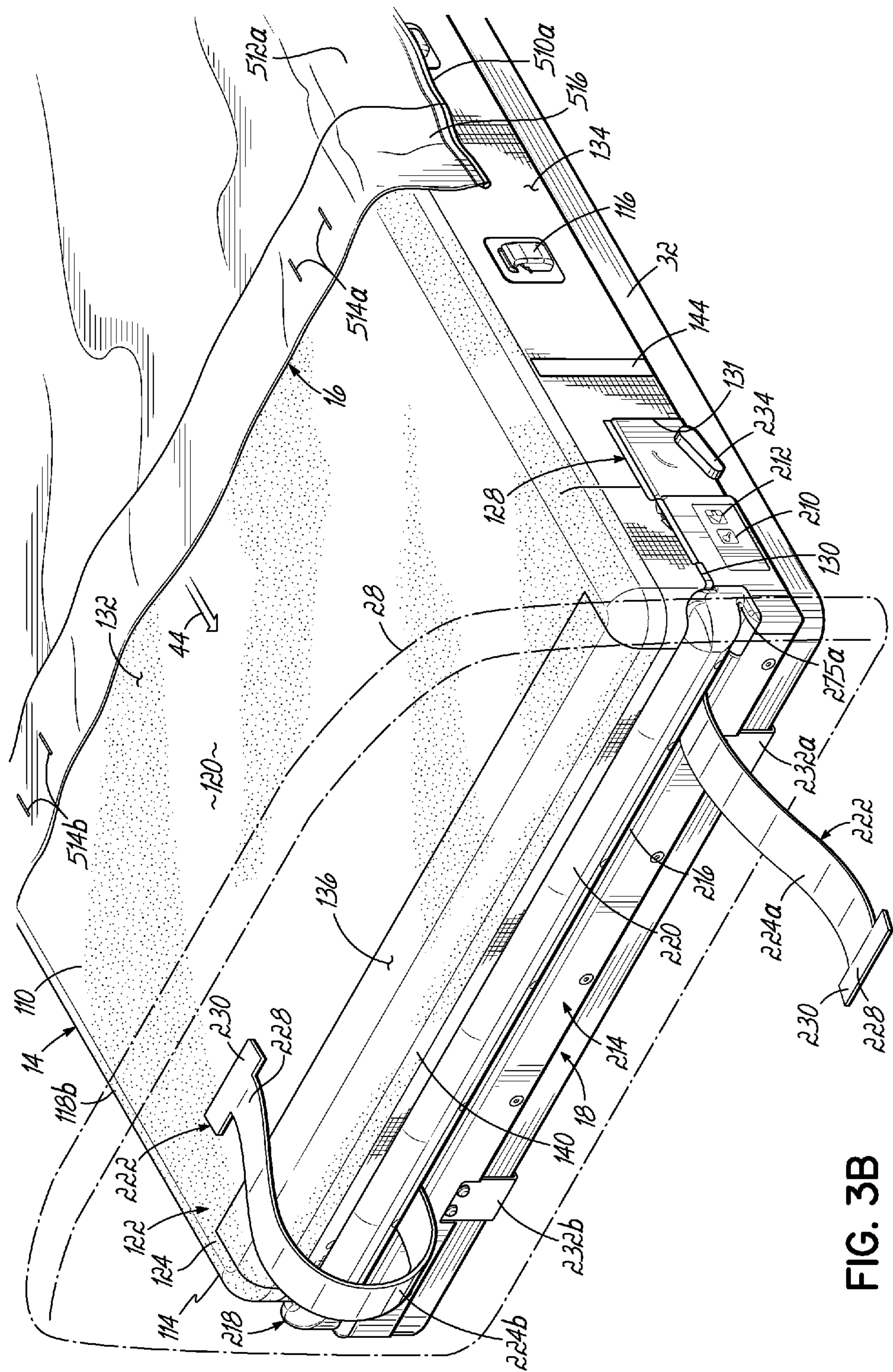


FIG. 3B

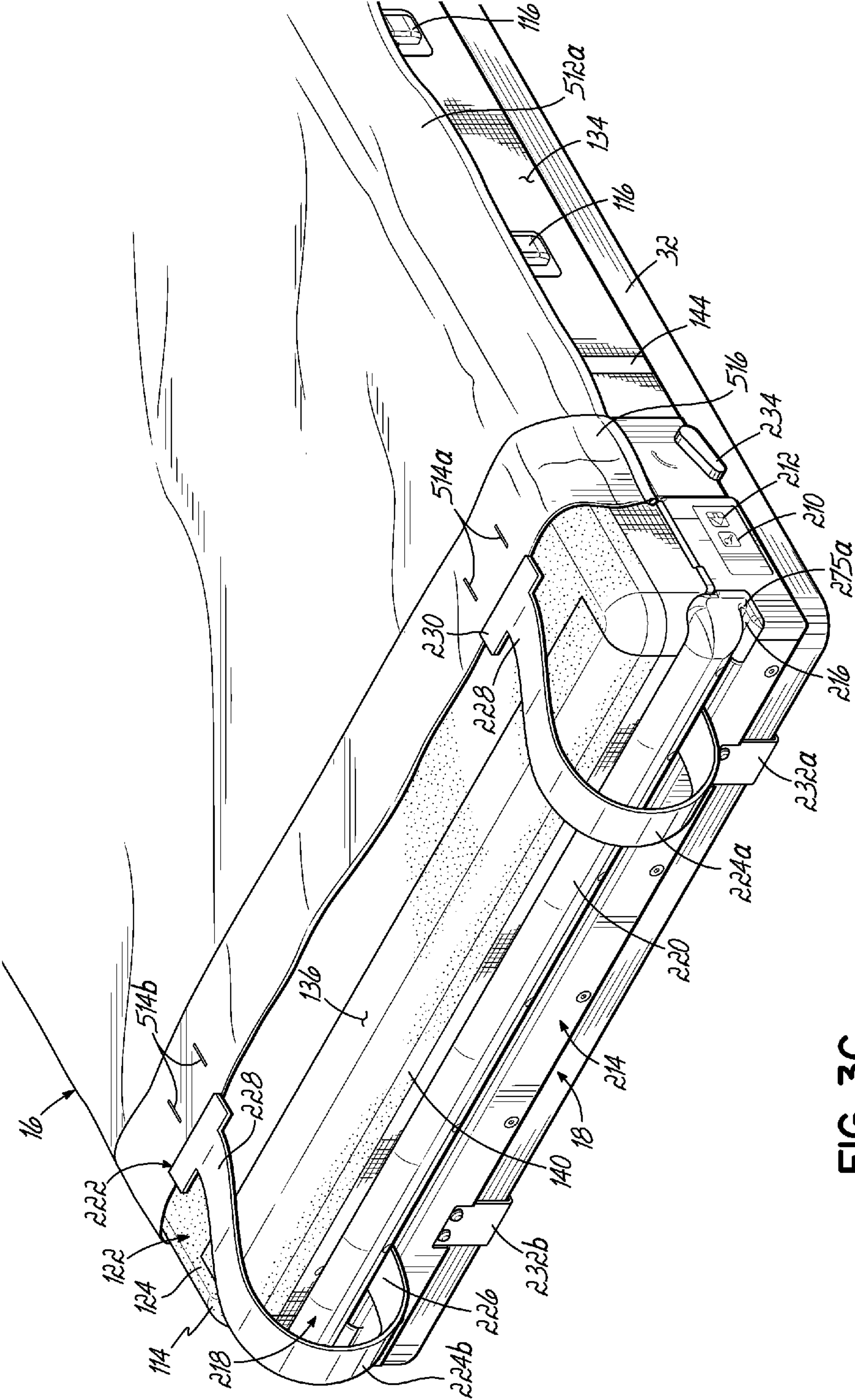
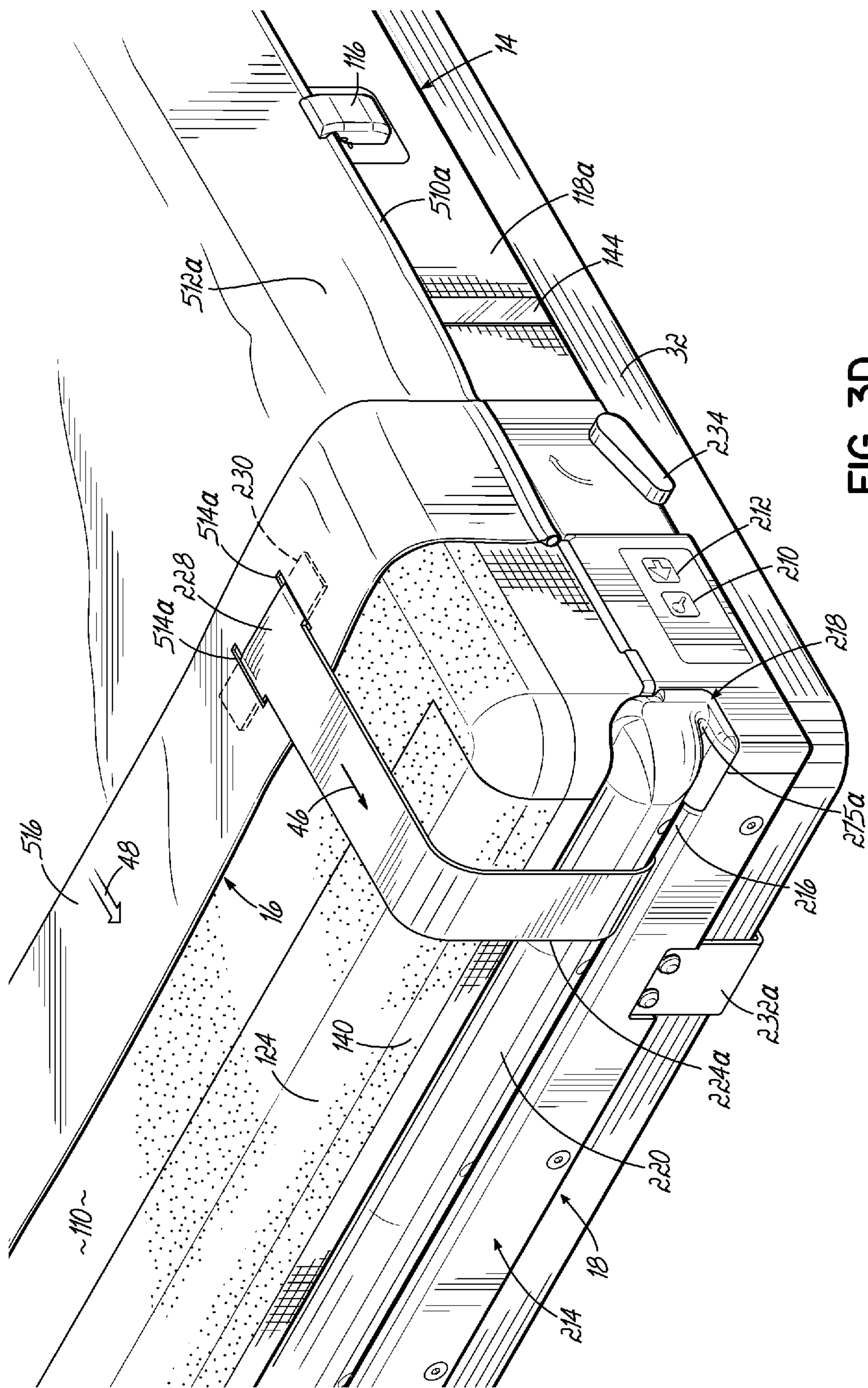


FIG. 3C



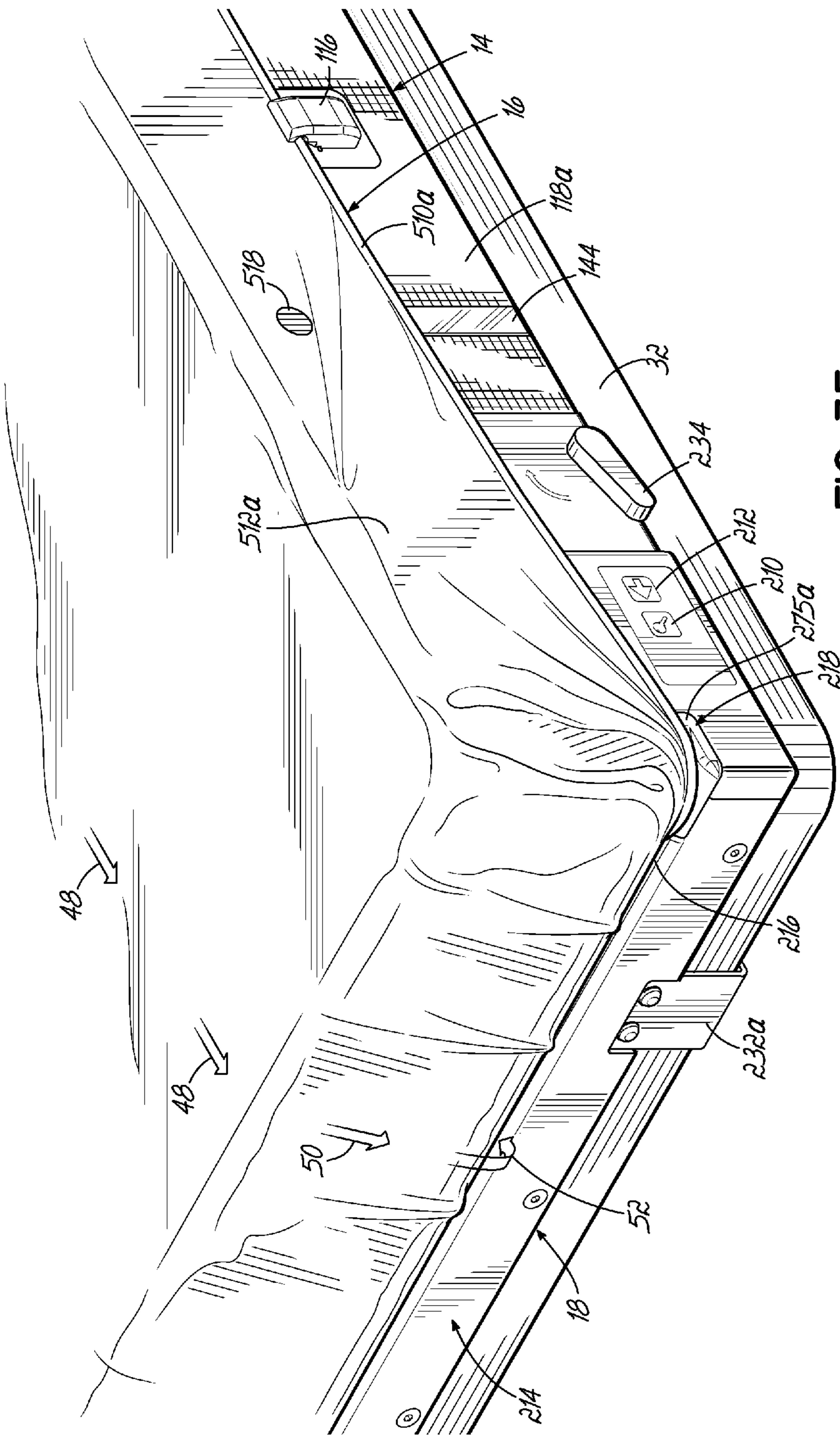
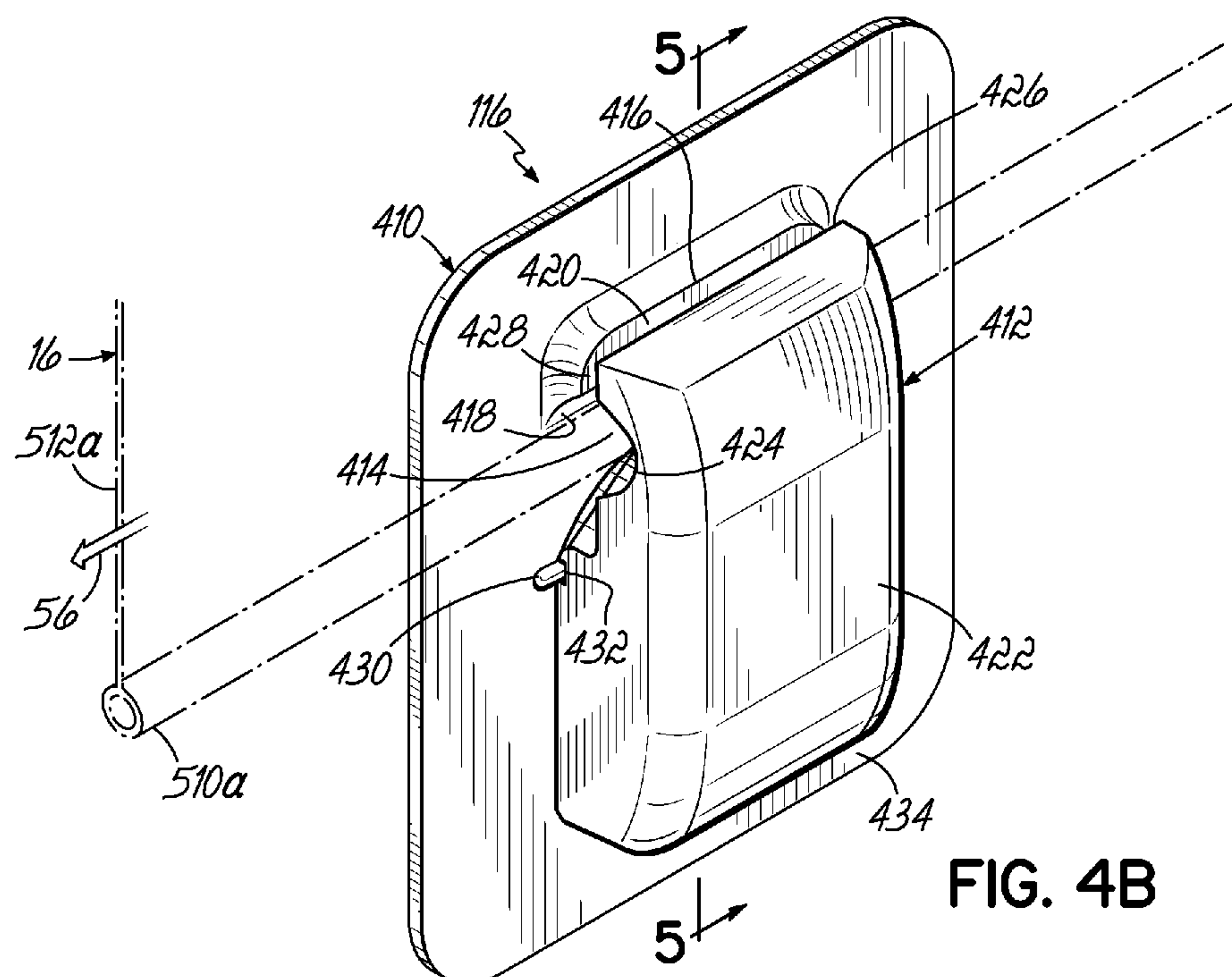
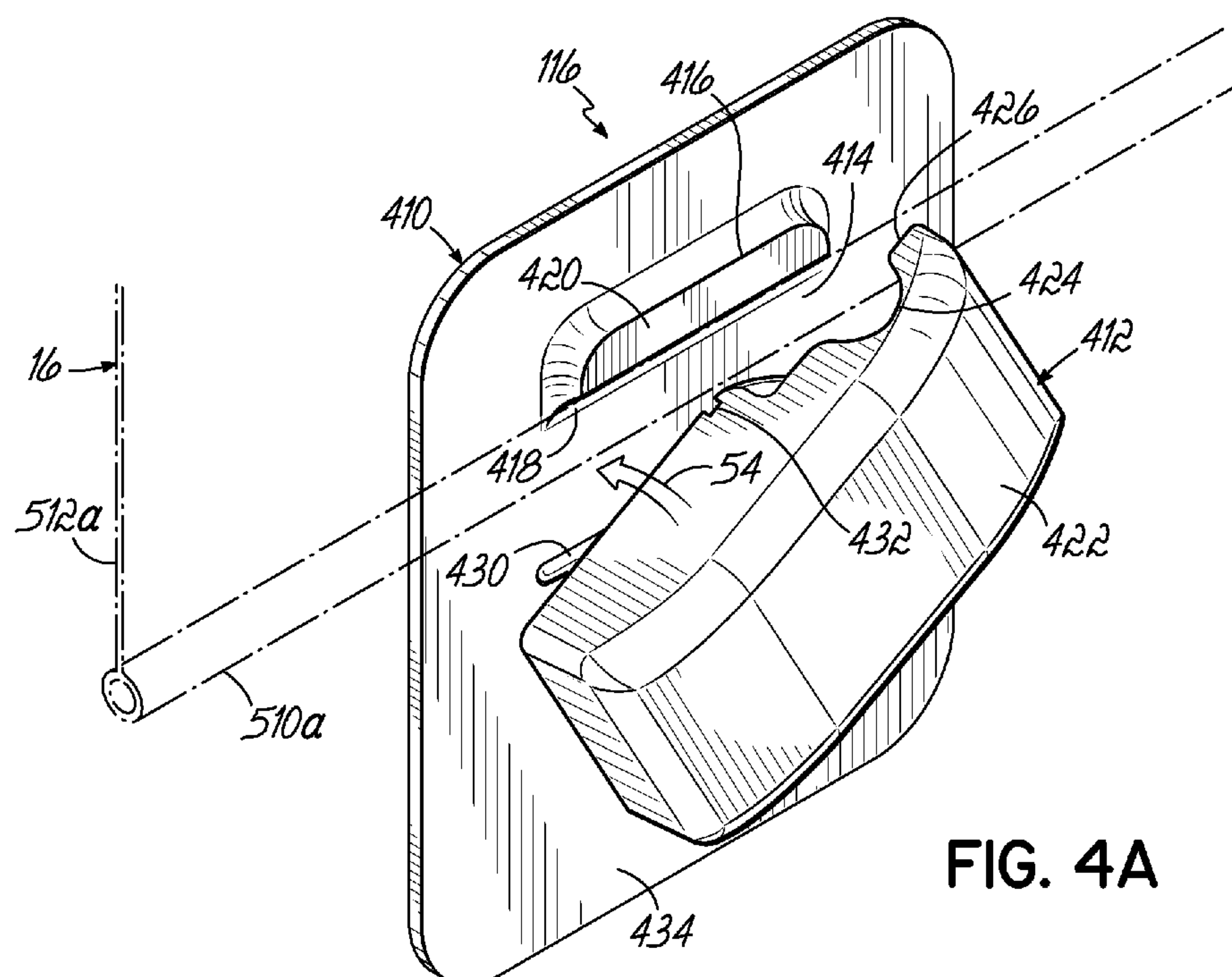


FIG. 3E



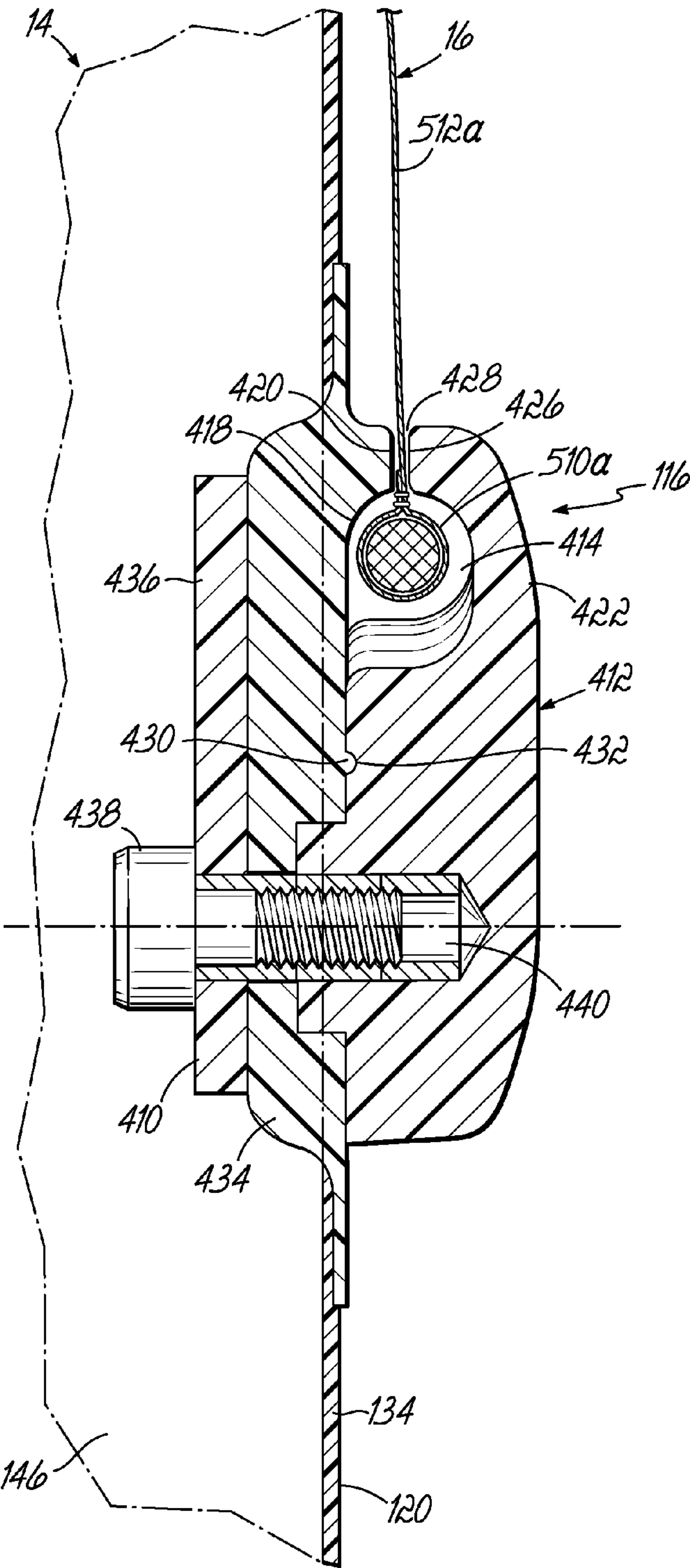


FIG. 5

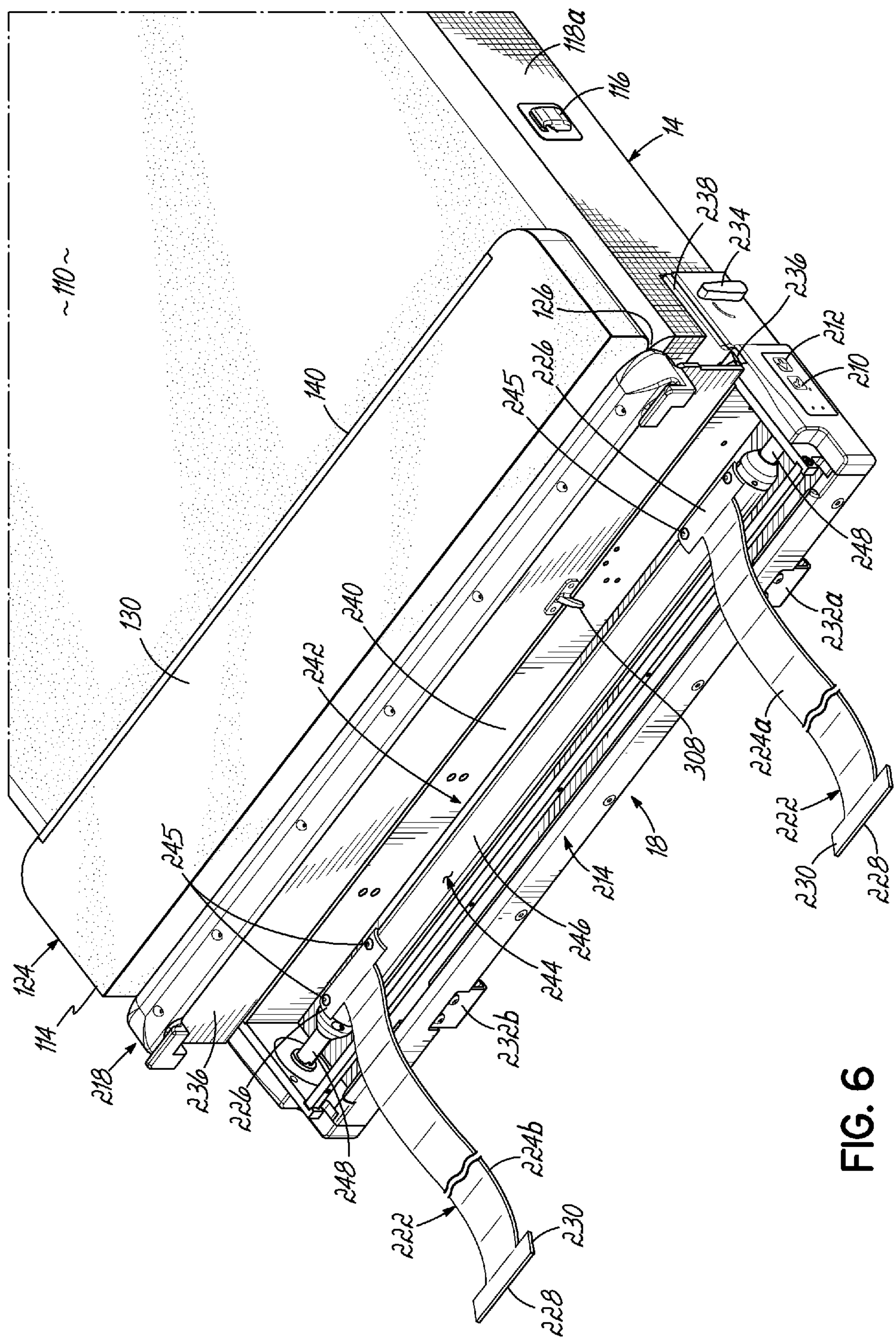
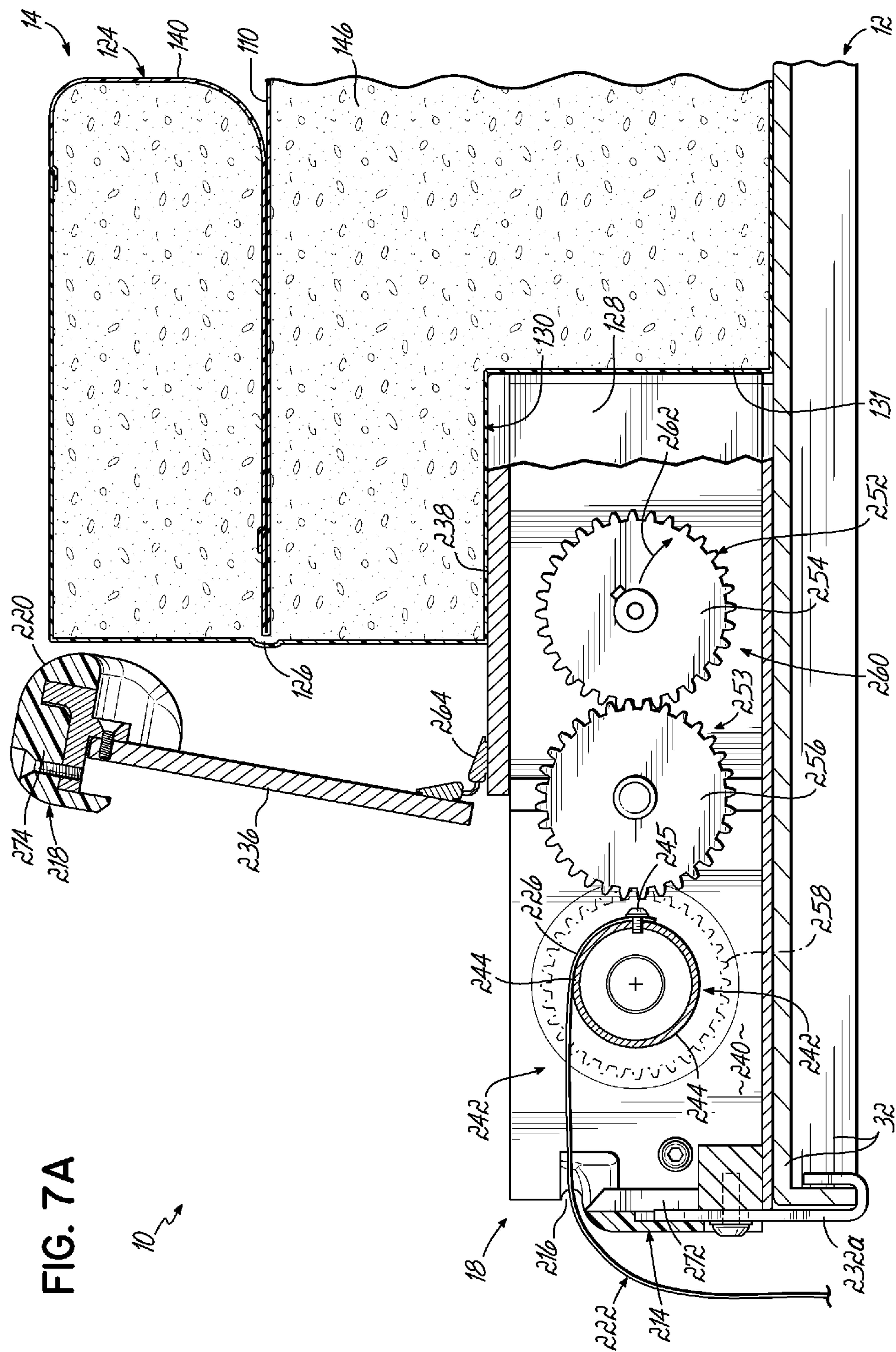


FIG. 6

FIG. 7A



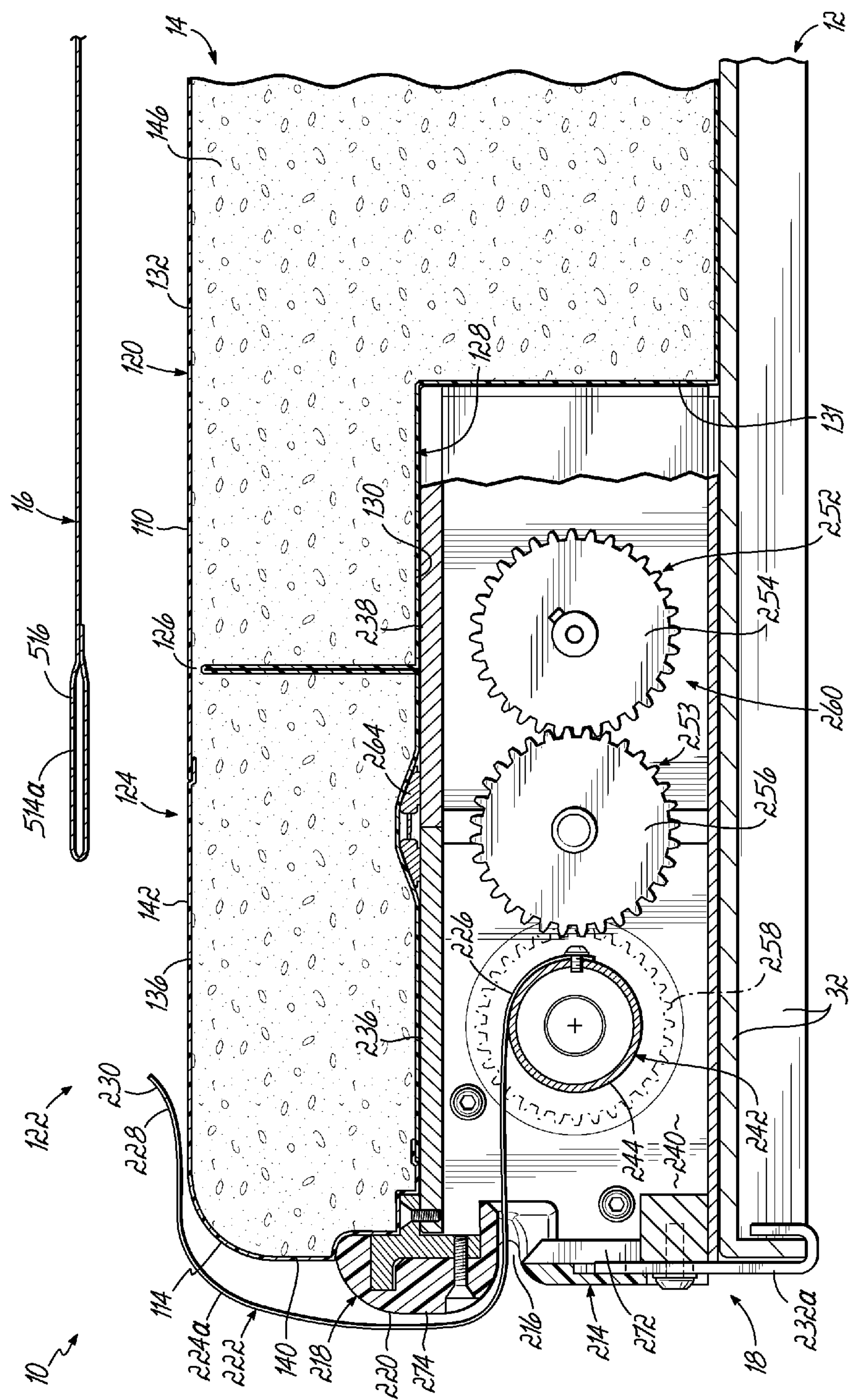


FIG. 7B

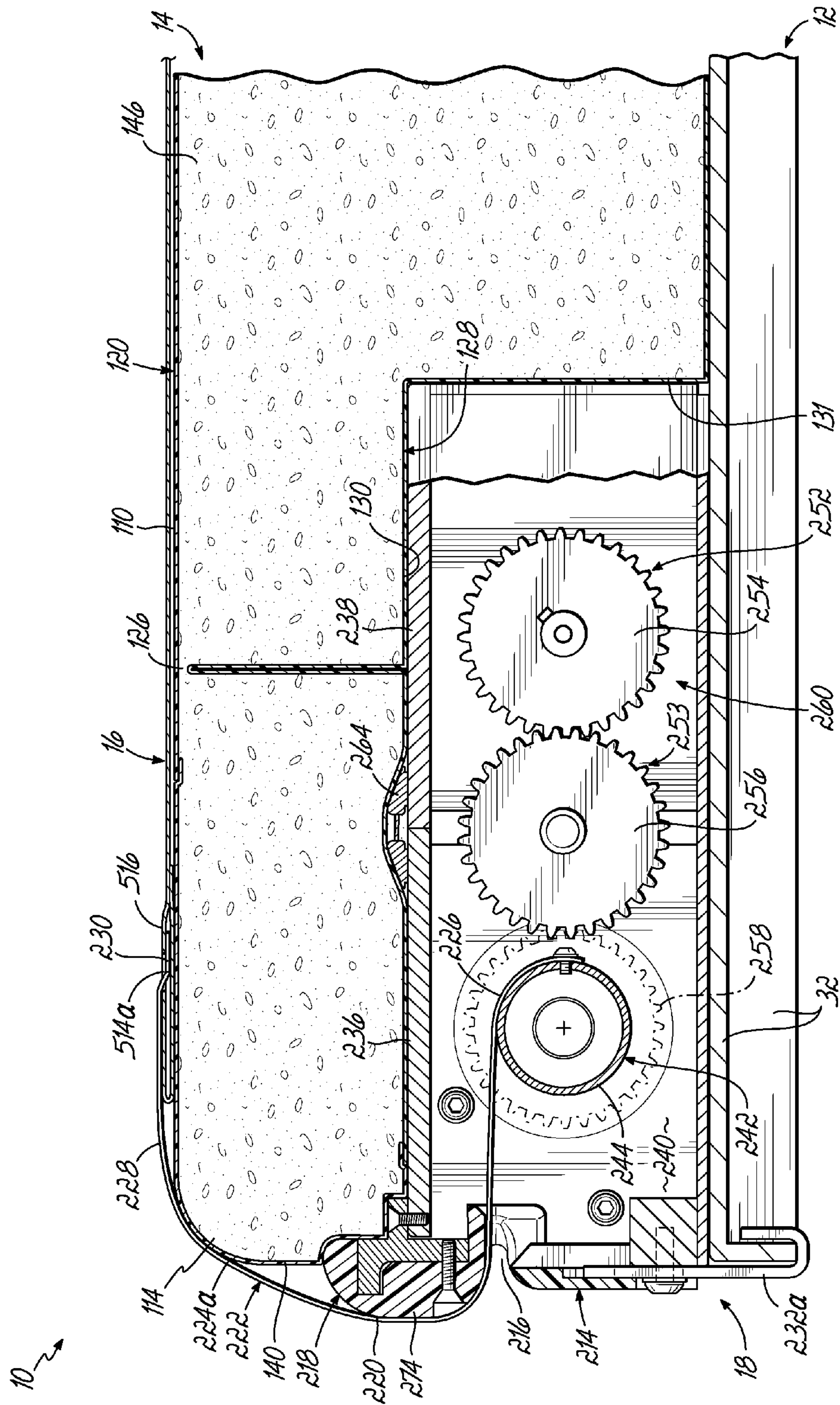


FIG. 7C

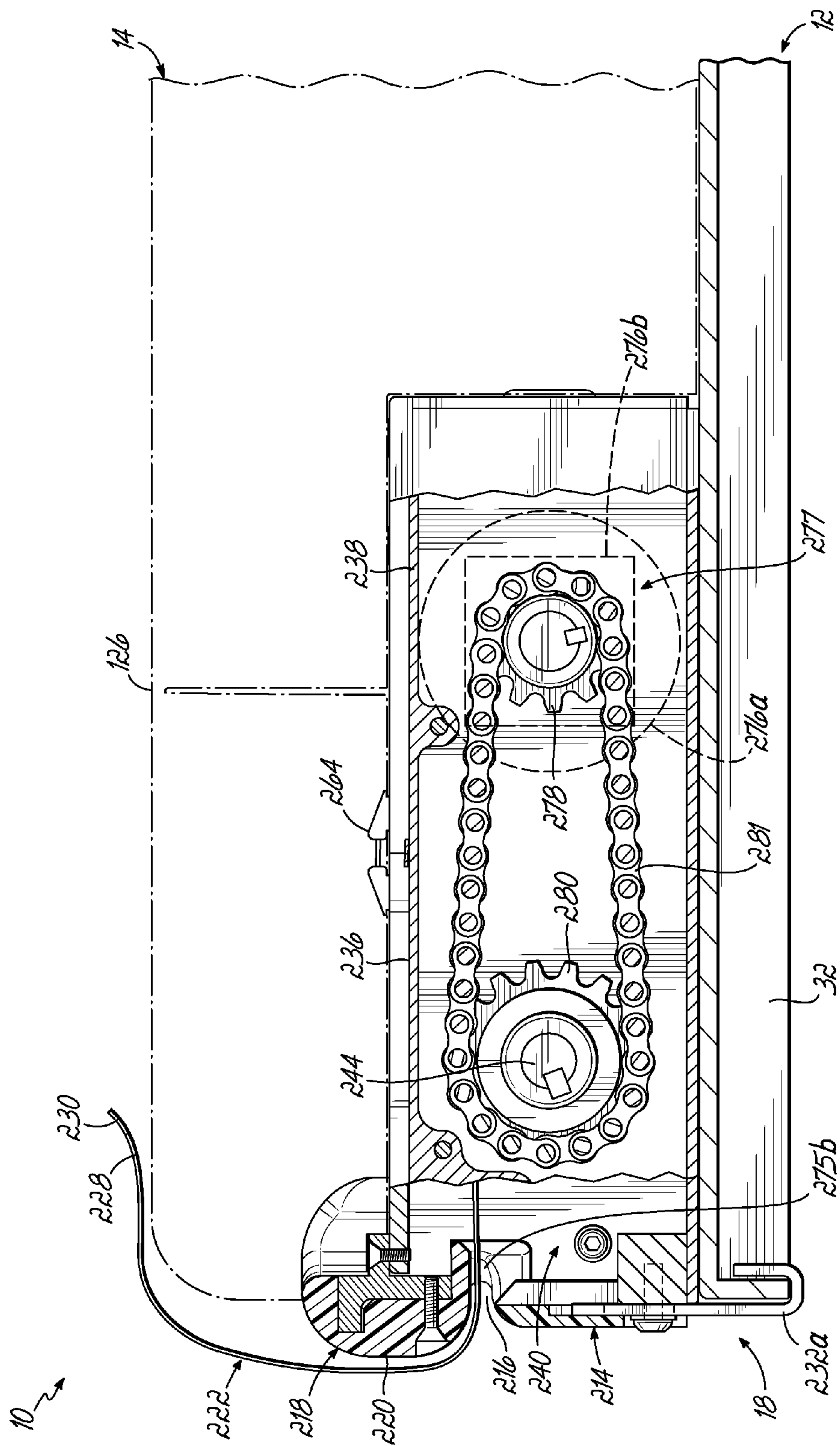


Fig. 8

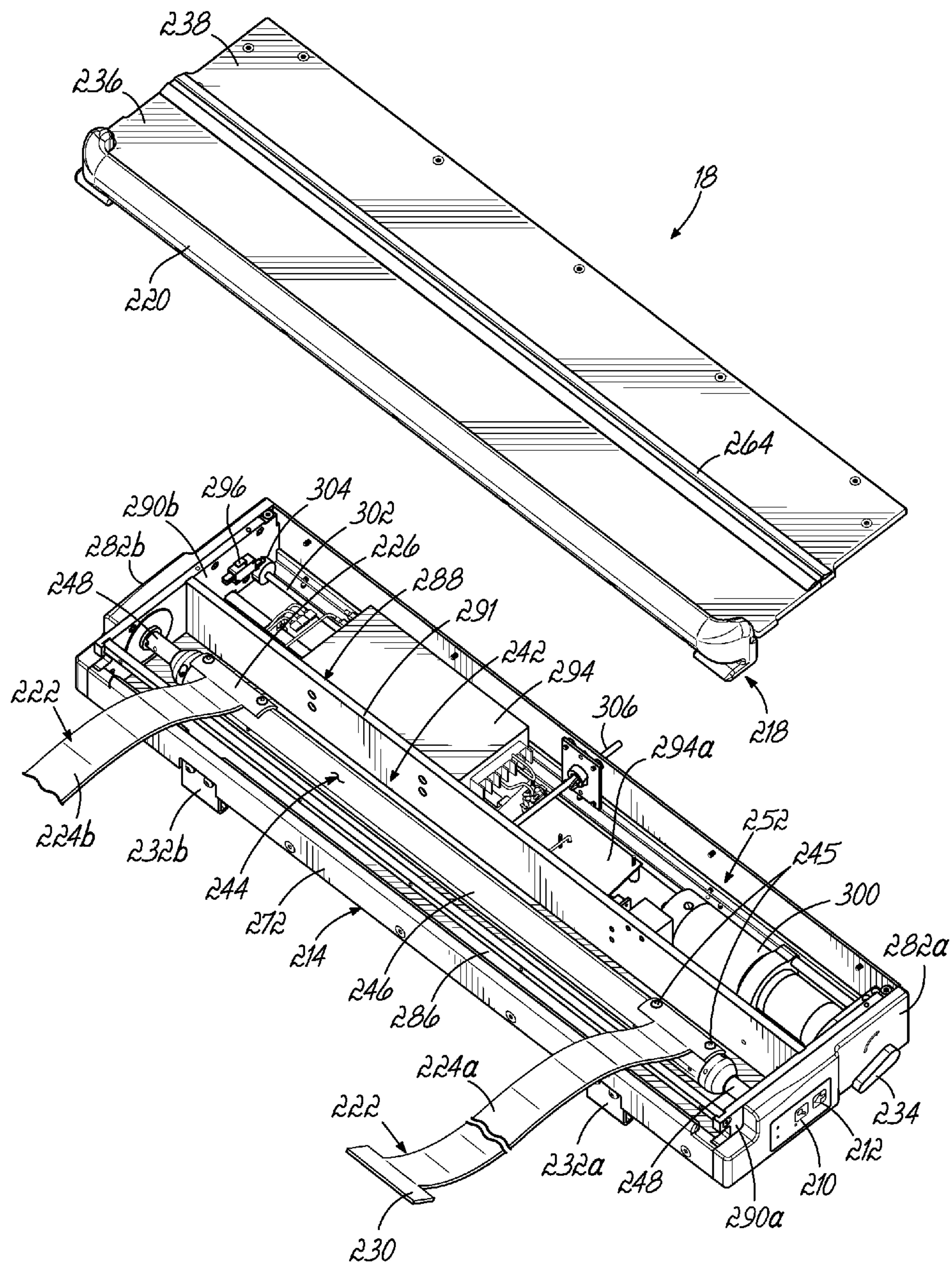


FIG. 9

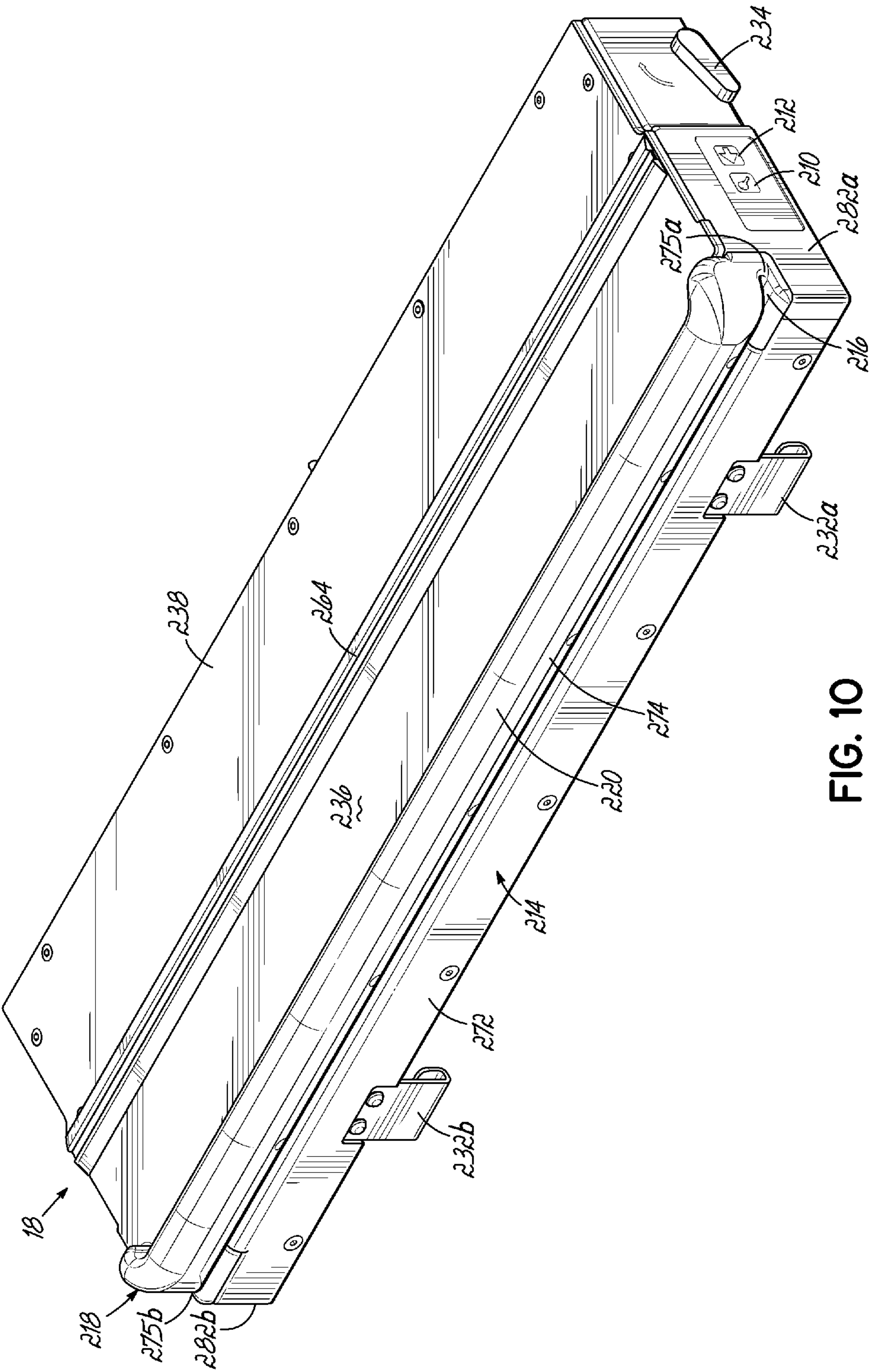


FIG. 10

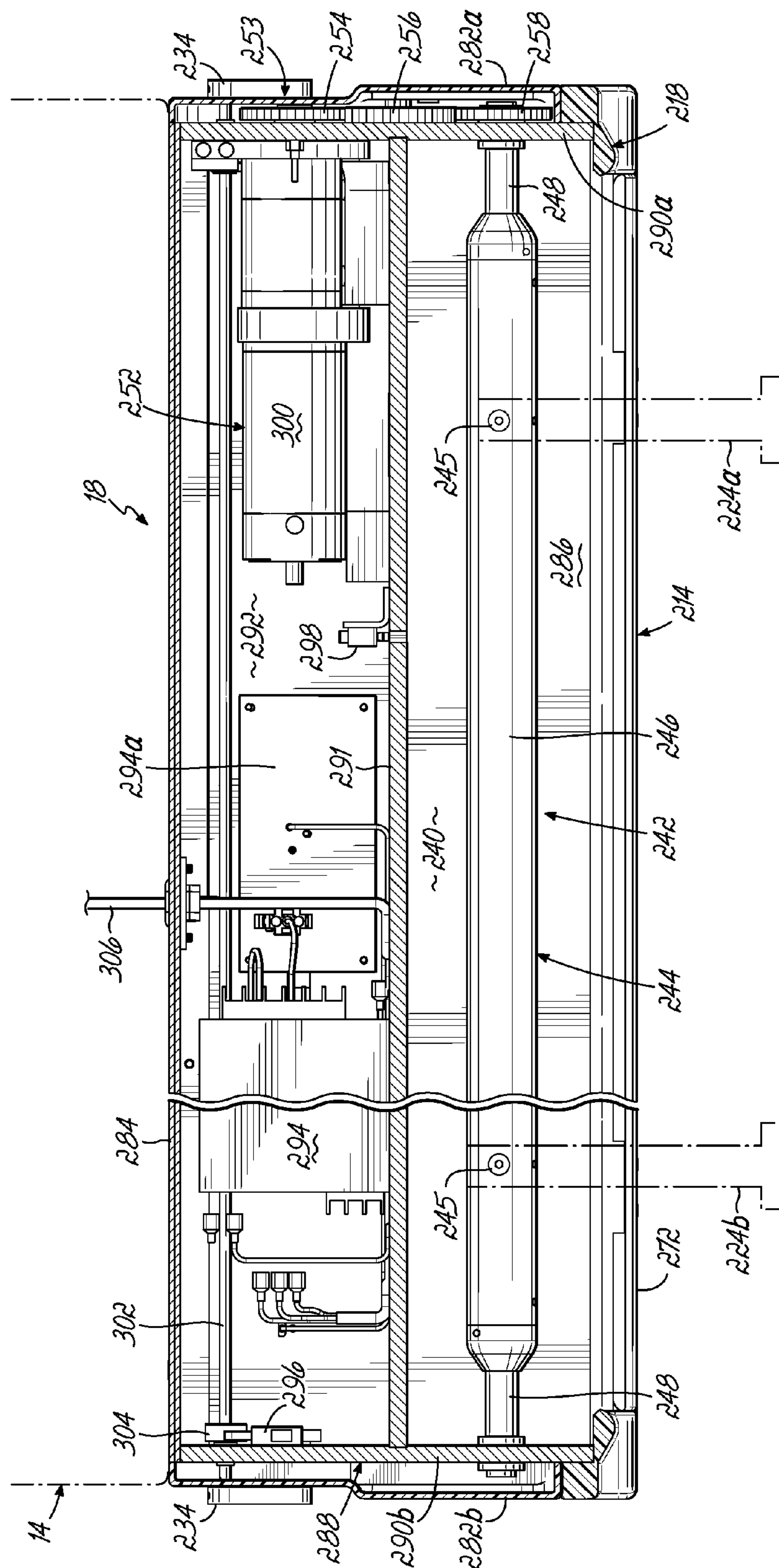


FIG. 11

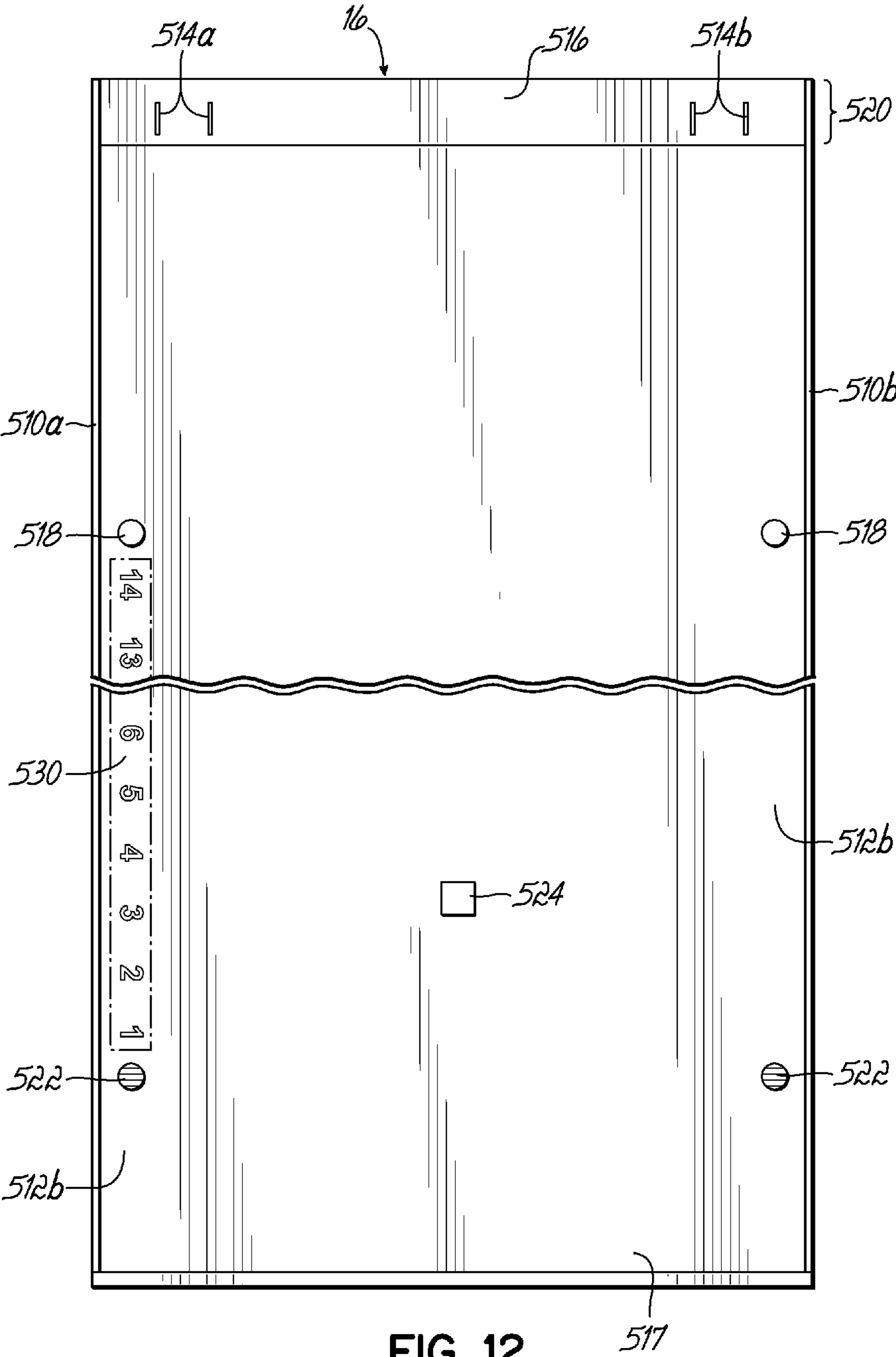


FIG. 12

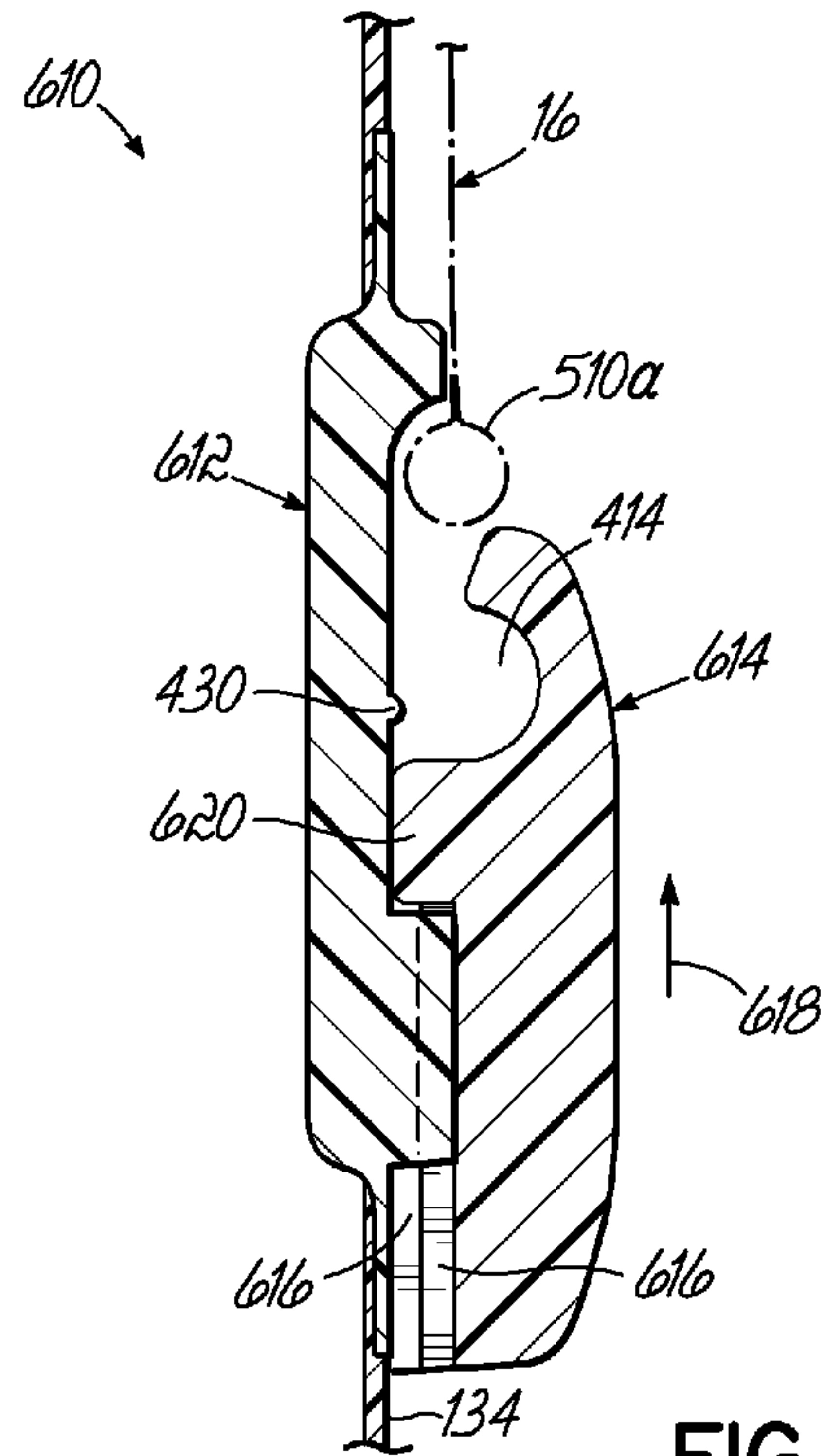


FIG. 13A

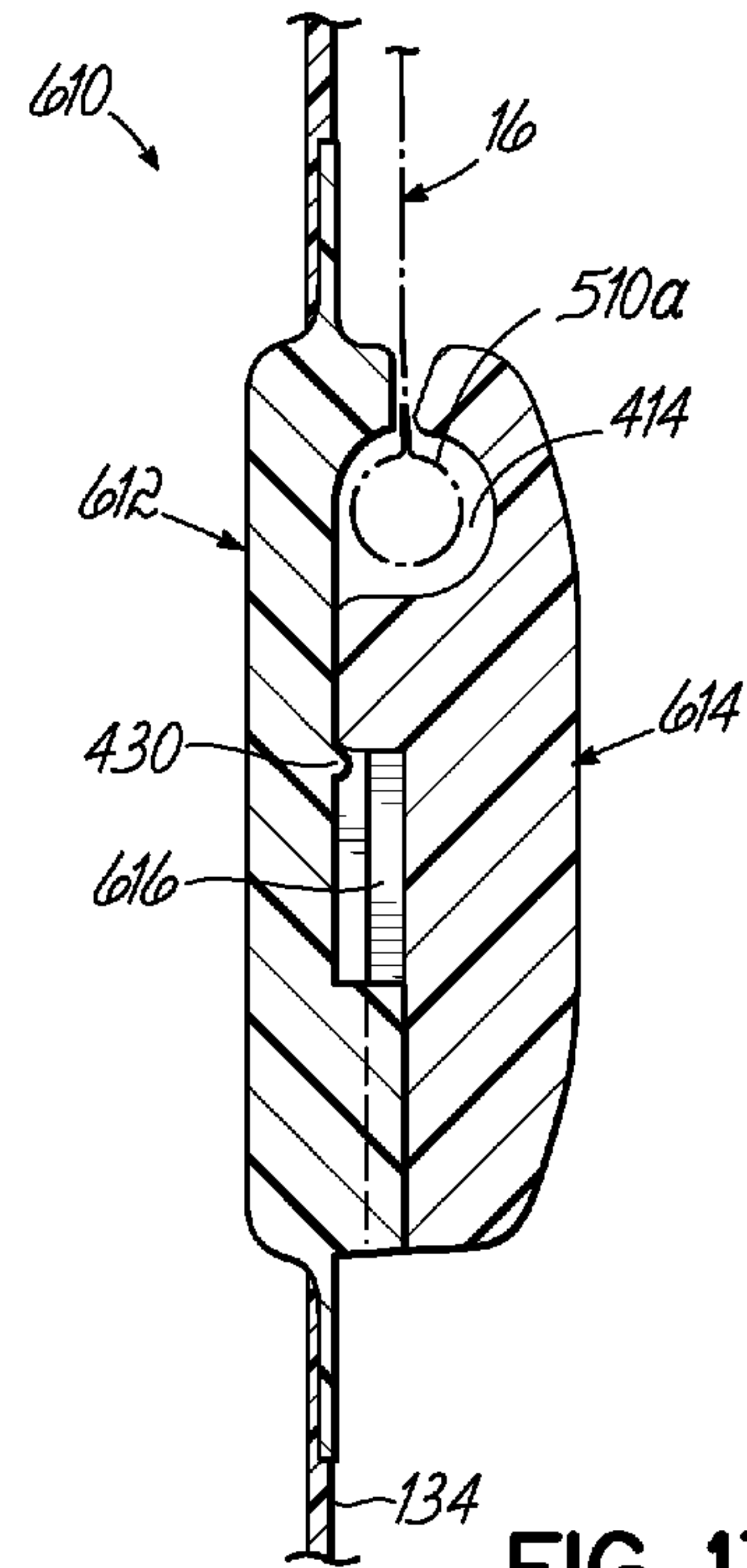


FIG. 13B

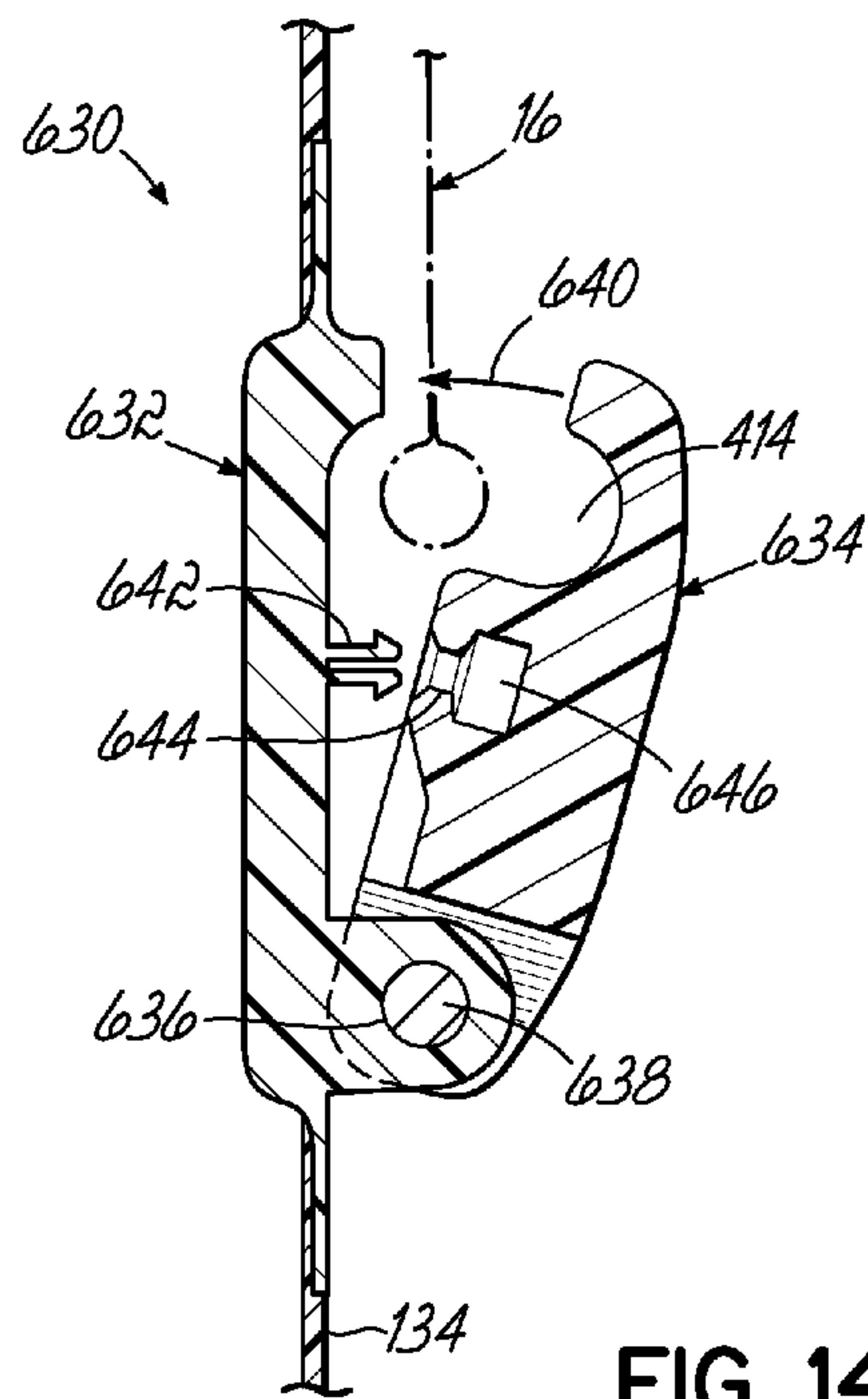


FIG. 14A

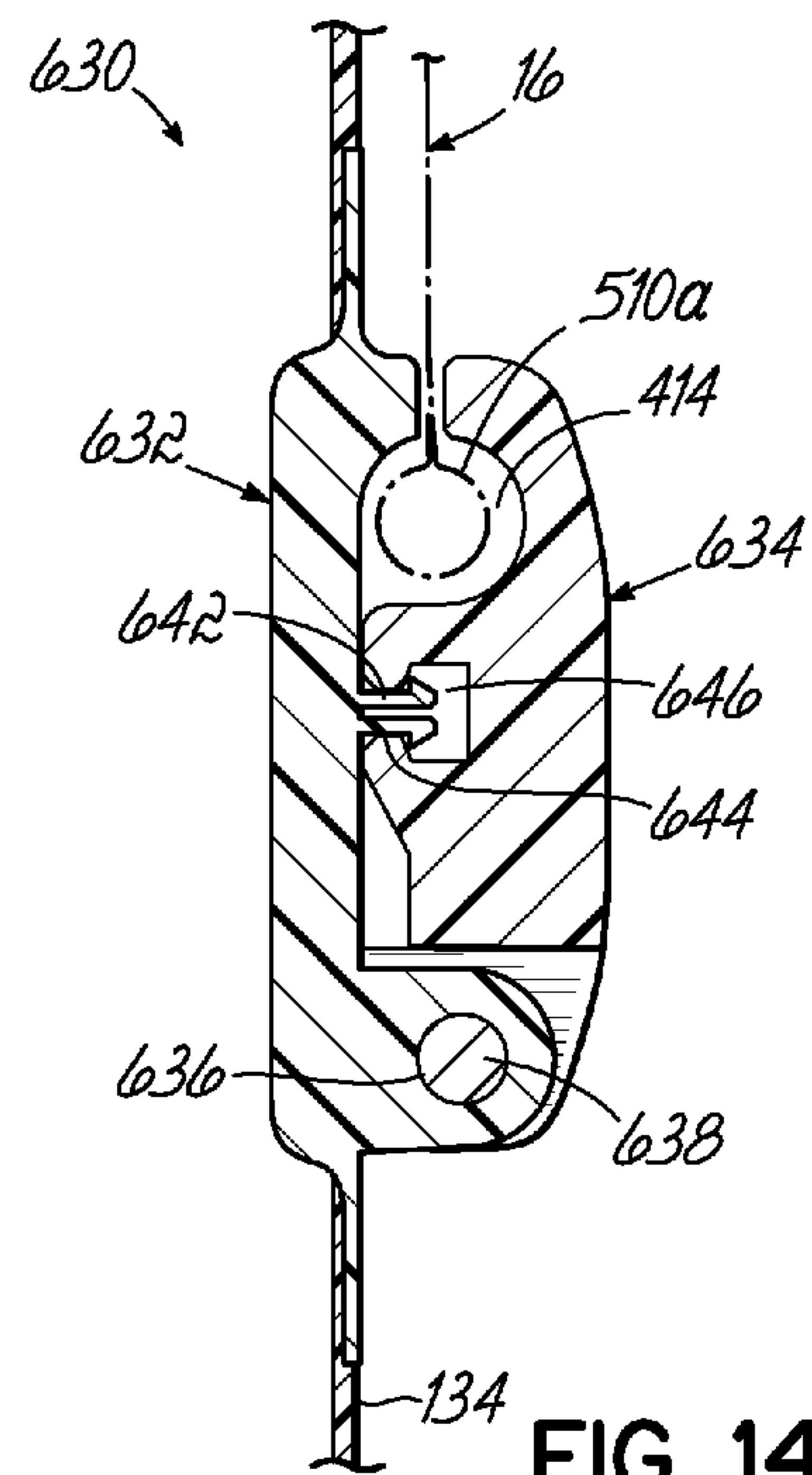


FIG. 14B

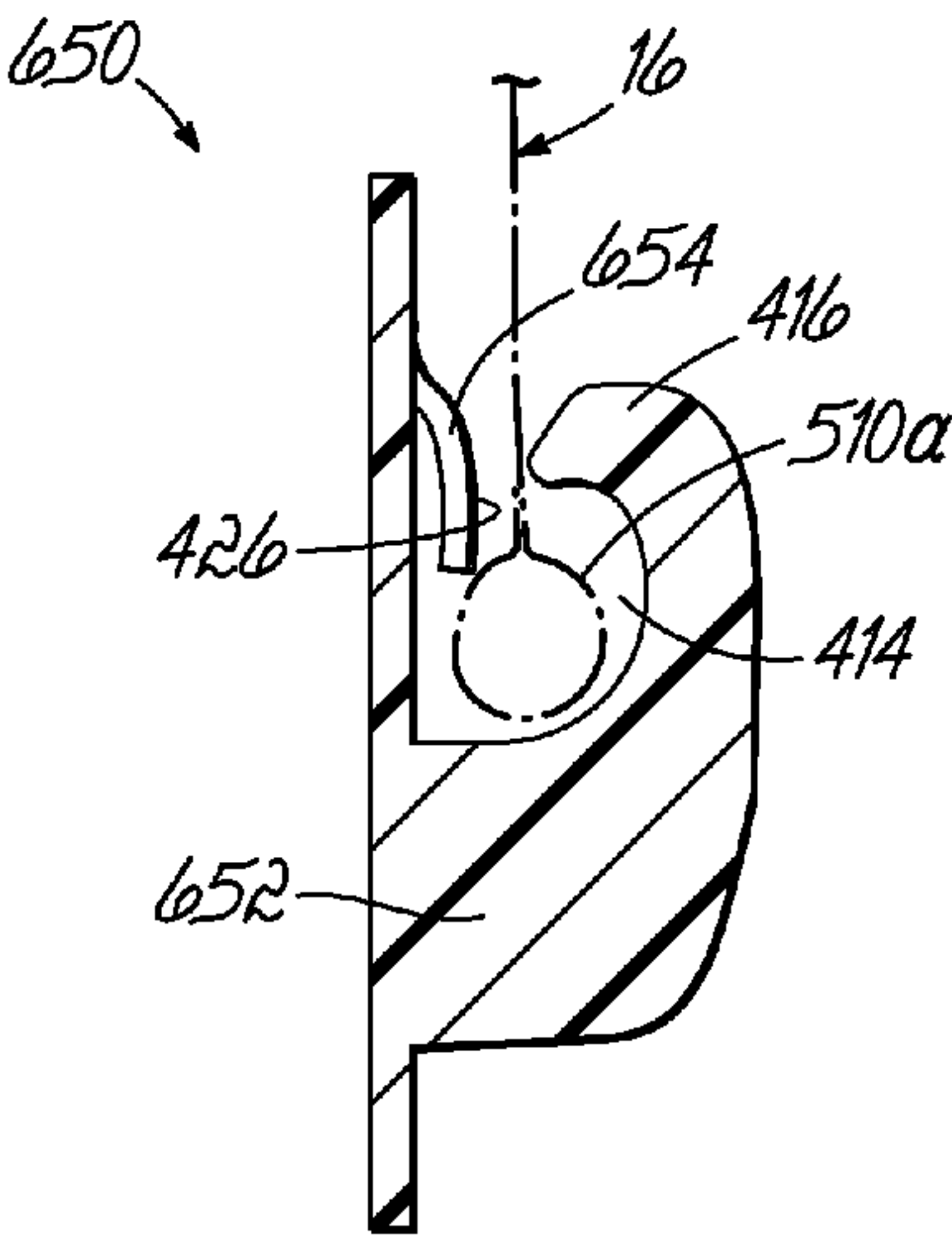


FIG. 15A

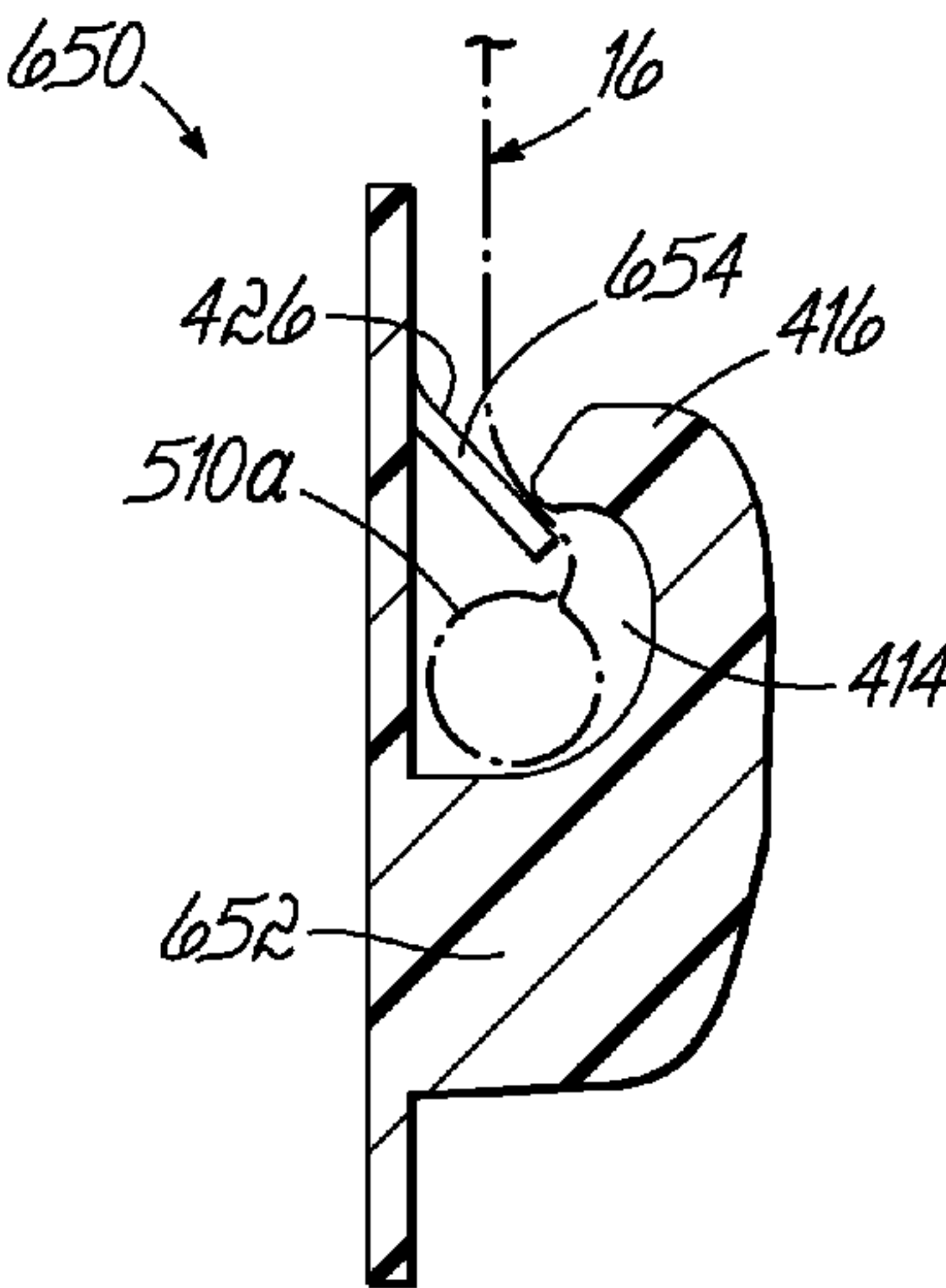


FIG. 15B

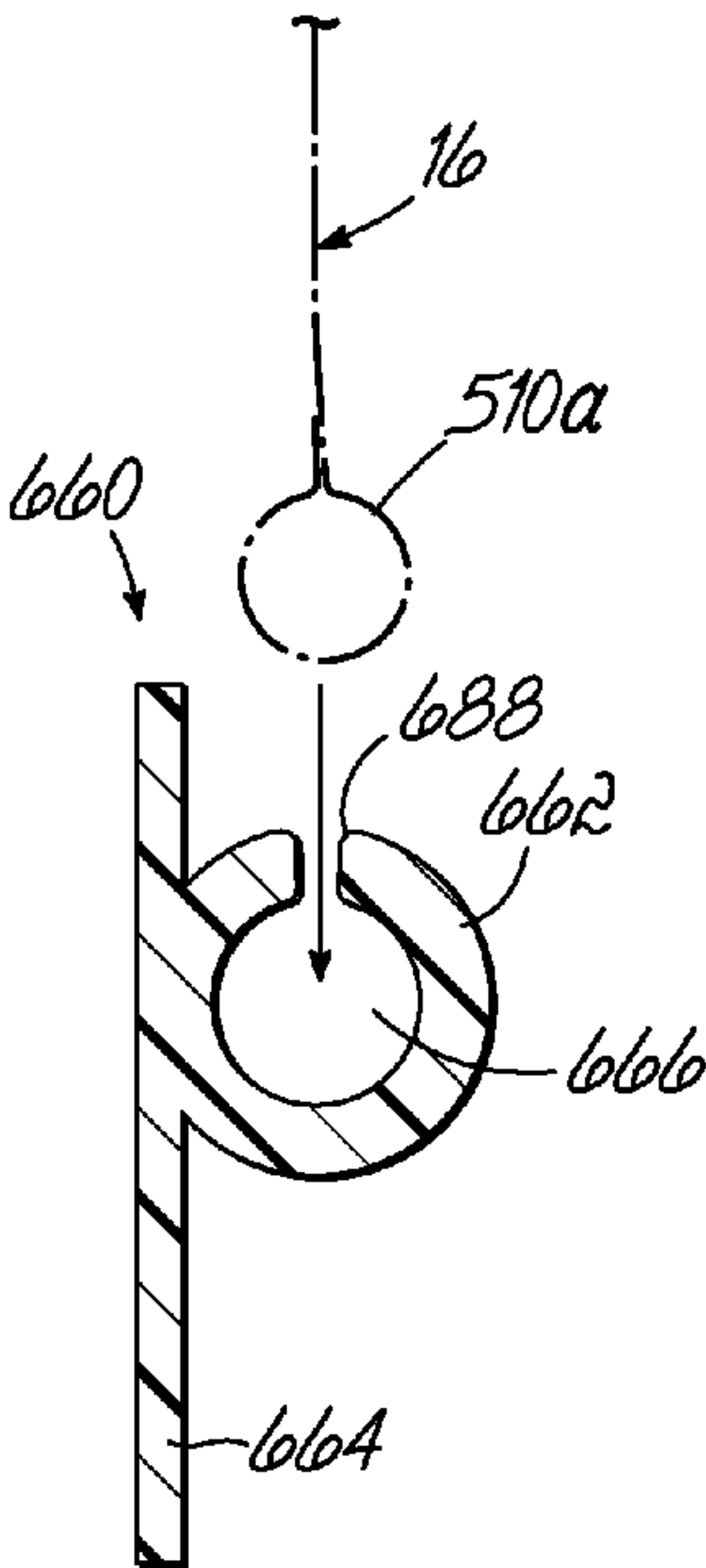


FIG. 16A

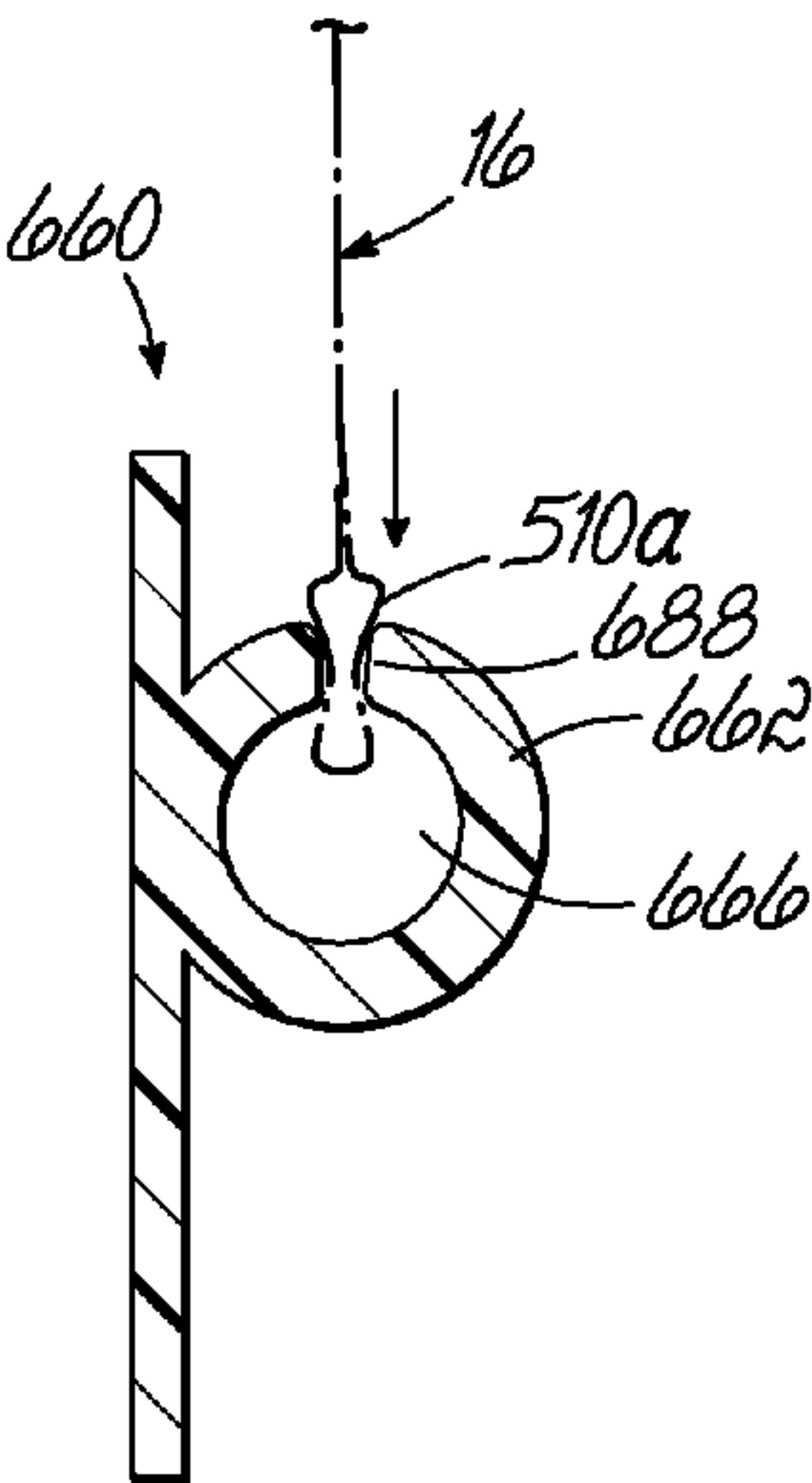


FIG. 16B

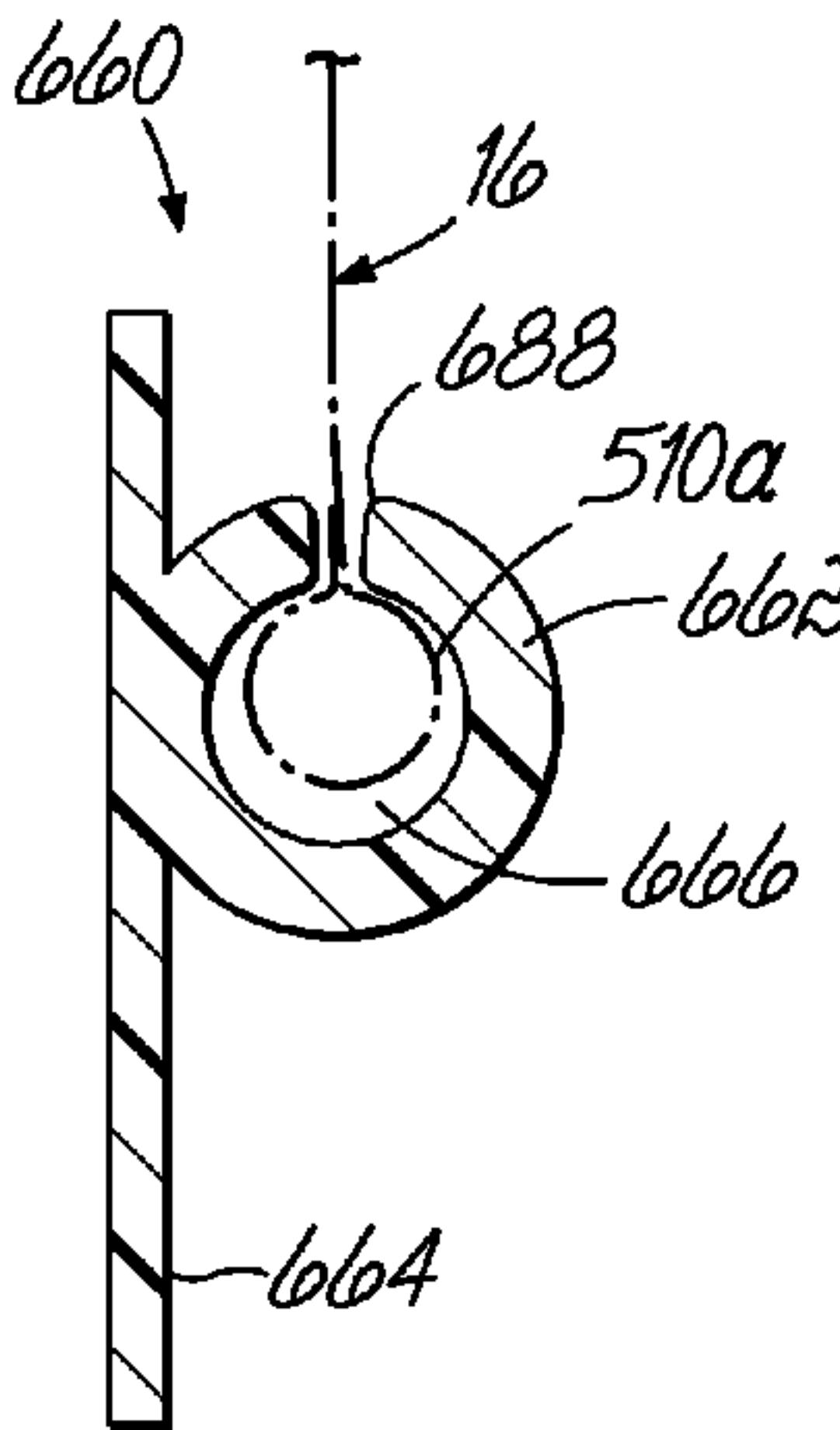


FIG. 16C

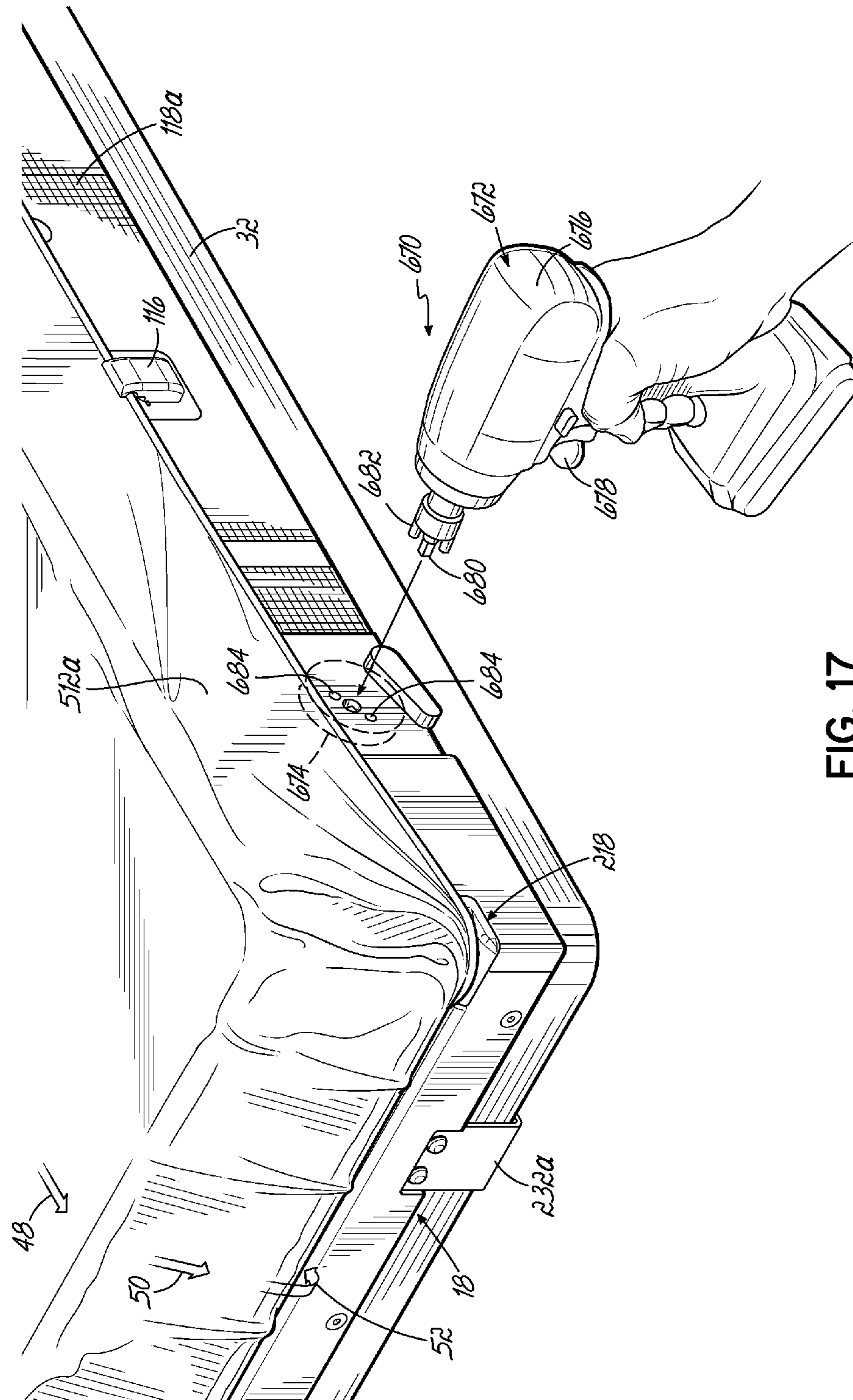


FIG. 17

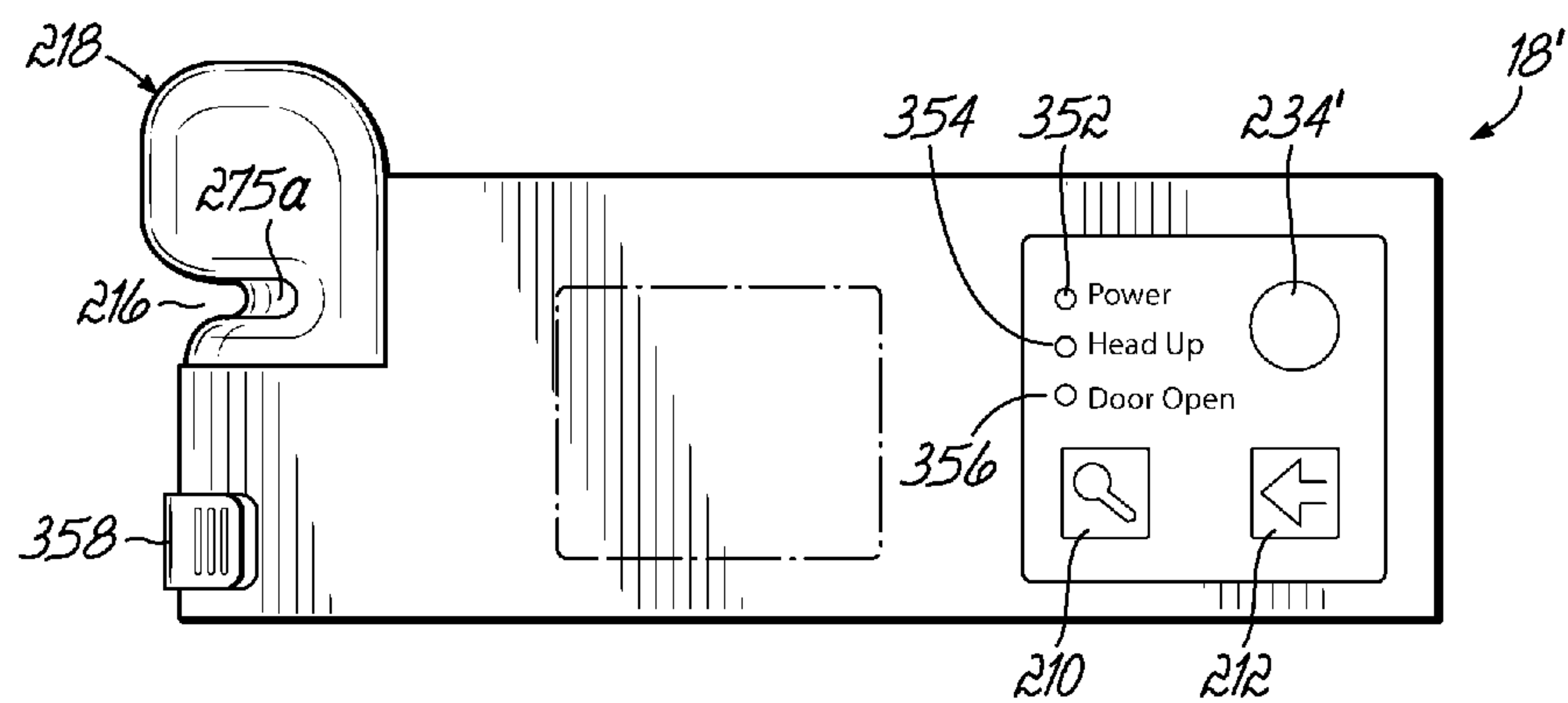


FIG. 18

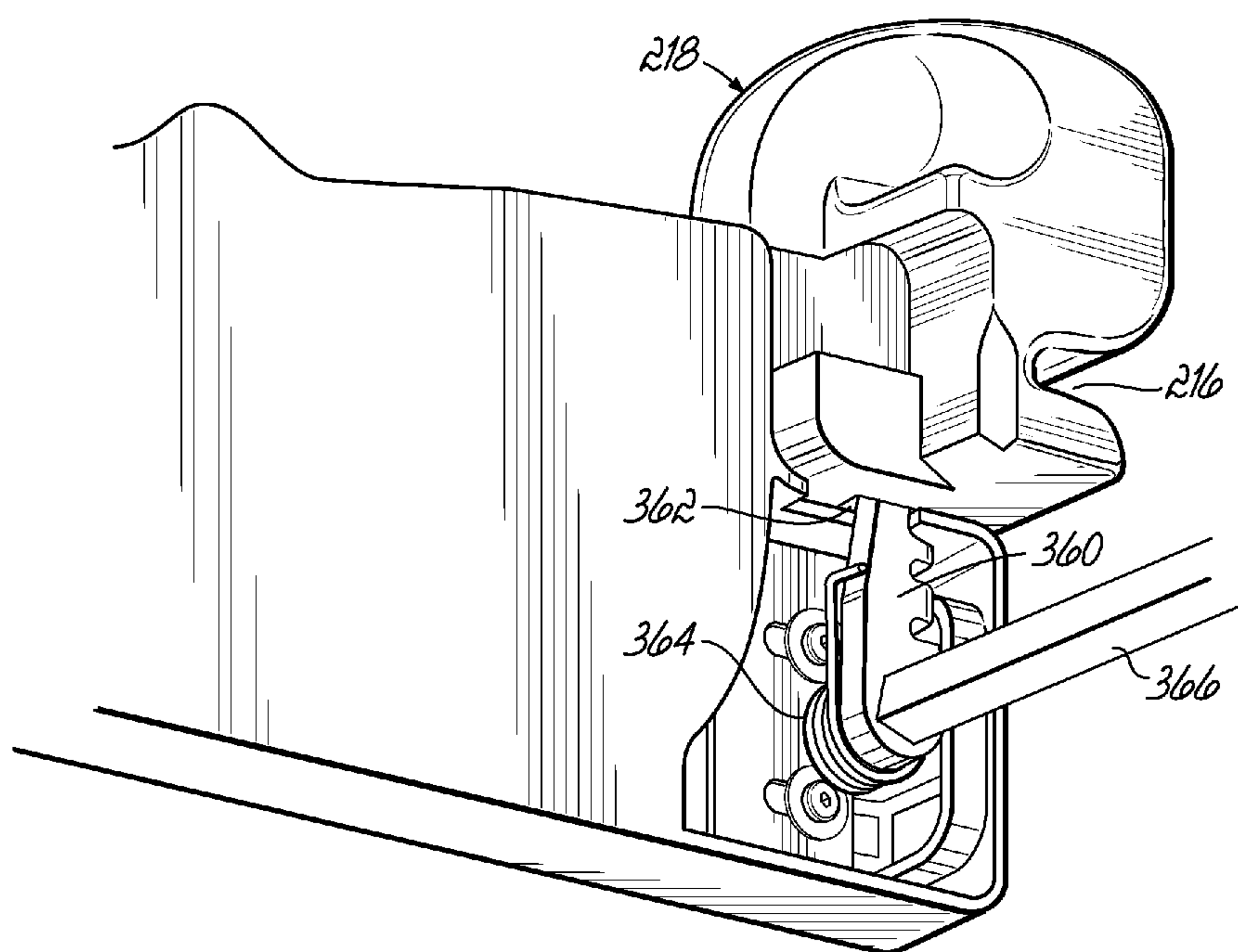


FIG. 19

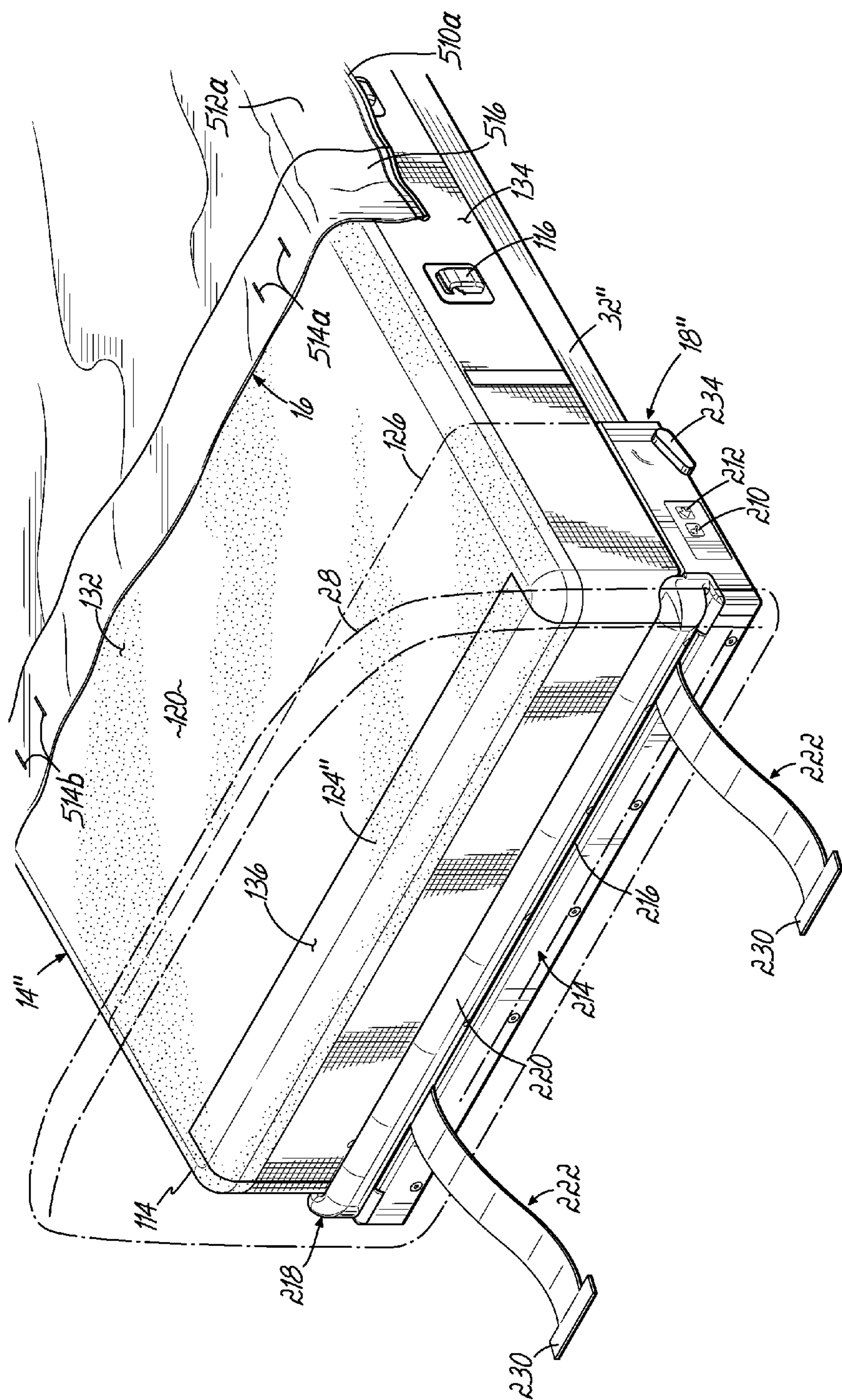
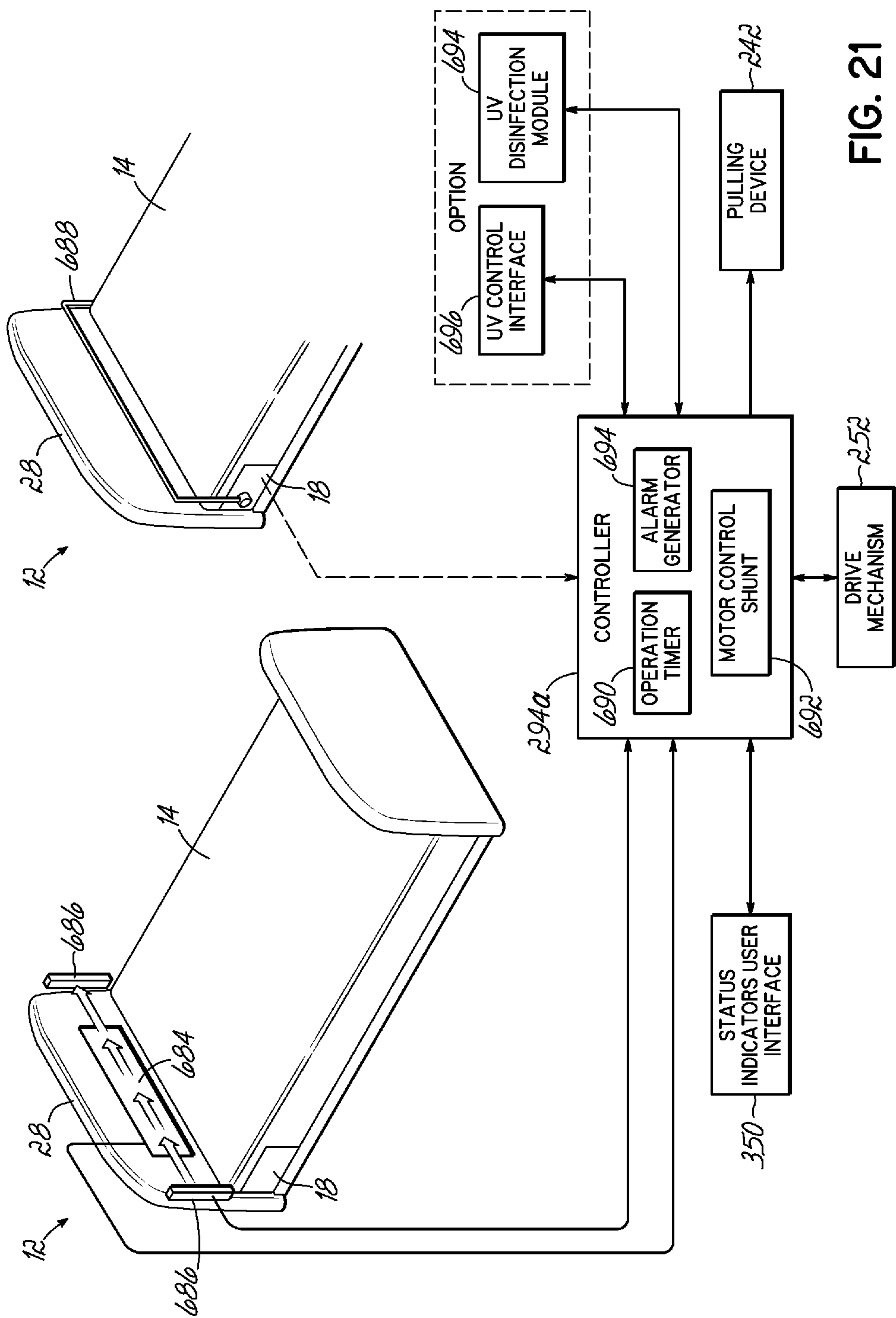


FIG. 20



PATIENT REPOSITIONING SYSTEM**FIELD OF THE INVENTION**

The present invention relates to a system and method for patient repositioning, and more particularly, to a safe, efficient and user-friendly system and method for repositioning a patient by moving the patient toward a head end of a bed.

SUMMARY OF THE DISCLOSURE

Since at least the 1950's, it has been recognized that a person supported on an articulating bed, such as a hospital bed or other type of conventional health care bed, tends to migrate from the head end of the bed toward the foot end of the bed when the head end of the bed is raised. Generally, this problem has been addressed by moving the patient back toward the head end of the bed, either by manually lifting and pulling the patient or by using a lifting device to move the patient.

The problems associated with manually pulling a patient are well-recognized, and include potential injury to the puller, i.e., the caregiver(s), often one or more nurses. And certain factors can further aggravate this problem, such as a shortage of nurses and/or an obese or uncooperative patient.

In addition to manual repositioning of a patient, a significant number of prior devices have been devised in an effort to solve this problem. For instance, U.S. Pat. Nos. 2,827,642; 4,796,313; 4,799,273; 4,819,283; 5,020,171; 5,697,109; 5,737,781; 6,615,423; 6,722,456; 2005/0217,023; 7,003,819; 7,293,303; 7,487,558; 7,725,964; and 2012/0144581 show and describe some examples of such prior structures. Some of these devices use a hand crank to manually wind a bed sheet toward the head end of a bed, with the patient supported thereon. Some use the bed frame and/or the headboard of the bed. Some use pulleys and/or suspension devices. But despite the relatively high number of devices which purport to resolve the above-described problem, applicants are unaware of any commercially viable product on the U.S. market which adequately addresses this problem. In other words, despite the seemingly simple nature of this problem, and the multiple and well-documented prior efforts at solving this problem, this problem has not been adequately solved.

Prior U.S. Pat. No. 8,087,109, entitled "Patient Positioning Device," which is expressly incorporated by reference herein, in its entirety, represents a significant step toward solving this problem. The '109 patent discloses, in general, a device which pulls a sheet and a patient supported thereon toward the head end of the bed, with the sheet guided on opposite sides by a pair of spaced tracks which hold opposite side edges of the sheet. The owner of this present application also owns the '109 patent.

The present application represents a further advance in this field, with a safe, practical, robust, yet user-friendly solution to the above-described problem. Generally, the present invention achieves the solution to this problem by the cooperative interaction of three main components, namely, a mattress, a sheet, and a sheet receiver for pulling the sheet toward a head end of the mattress. Generally, in the context of this specification, the sheet receiver encompasses a housing and a drive mechanism. The mattress has a movable head end piece, i.e., preferably foldable about a fold line, which moves to enable access to the housing and the drive mechanism contained therein. The housing includes an access door to enable a user to readily access a sheet chamber within the housing.

With this arrangement, by folding the head end piece of the mattress and by opening the access door to the housing, a user may readily access the sheet chamber without any accompanying need to articulate a deck on which the mattress and the housing reside. This structure greatly facilitates cleaning and maintenance of the components located within the housing. In the hospital environment, over the past few years infection control has become increasingly more important. By providing simple and easy access to these components, this system and method helps the user to take steps to fight against instances of infection. But at the same time, the housing protects the components located therein, and does so within a volume that does not interfere with a standard bed deck, to which the housing is preferably secured.

This system and method also facilitates the simple and repeatable attachment of the sheet to be pulled with the pulling device, which is located in the housing. In fact, this system and method eliminates the need to raise the head end of the mattress, or to articulate the bed, in order to change the sheet, to disinfect the housing and the components located within the housing for infection control.

More specifically, the housing includes a slot through which at least one connector extends, to connect to a head end of the sheet, and thereby enable the sheet to be pulled into the housing when attached to the connector. The connector may include one or more straps. The slot is preferably defined in part by the access door of the housing, to facilitate routing of the connector to the sheet for attachment. The housing also includes one or more contoured surfaces located adjacent the slot, to facilitate movement of the sheet by reducing the friction on the sheet and compression of the mattress as the sheet moves toward and into the slot. Also, the top head end surface of the mattress, at the corner, may have reduced elasticity to facilitate slidability of the sheet thereover as it is pulled toward the slot.

The sheet has a length that is significantly longer than the mattress, to enable multiple repositioning operations with the same sheet. Also, the sheet has a width that is greater than that of the mattress, and has opposing beaded edges, with each beaded edge retained along one outer side of the mattress by a plurality of spaced retainers secured to the mattress. Each of the retainers has an open position to enable placement of the beaded edge of the sheet therein, and a closed position to retain the beaded edge therein. In the closed position, the retainers permit the sheet to be pulled toward the head end of the mattress. In this preferred embodiment, by locating the retainers on the outer sides of the mattress, the entire top surface of the mattress is available for use by the patient, without obstruction. In addition, with this embodiment there are no obstructions along the perimeter of the top surface of the mattress. The retainers also manage the sheet's longitudinal perimeter, by preventing the upper ticking from becoming exposed. This management also creates a stable surface for the patient during ingress, egress and transfer.

The sheet includes at least one reinforced slit, to which a T-shaped tab is removably attachable, the T-shaped tab located at an outer end of a connector. The T-shaped tab quickly and easily slides within the reinforced slit, to enable pulling of the connector toward the head end of the mattress to also pull the sheet toward the head end. The other end of the connector is secured inside the housing, for instance, to a roller mounted therein, whereby rotation of the roller pulls the connector and the sheet attached thereto into the housing via the slot. The connector and the sheet wrap around the roller within the housing. Each repositioning of the patient causes more of the sheet length to wrap around the roller located in the housing.

By collecting the used sheet within the housing, this system and method accommodates multiple repositionings of the patient, without any commensurate entanglement of that portion of the sheet that has already been used. At the same time, the location and the shape of the housing, relative to the top surface of the mattress, eliminate the need for the sheet to span between various bed structures, and thereby create the potential for interference between the sheet and surrounding bed structures.

According to one aspect of the invention, the attachment structure between the connector and the sheet, i.e., the T-shaped tab and the reinforced slit, is designed so as to have a very small profile. This small profile facilitates movement of the attachment structure into the slot of the housing, to enable the connector and a head end of the sheet to sufficiently wrap around the roller so that, upon further rotation of the roller, the sheet is pulled toward the head end of the bed with enough pulling force to also pull a patient supported on the sheet. For example, the structure that is shown and described herein, i.e., two pairs of reinforced slits oriented longitudinal to the length of the sheet, and each of two T-shaped tabs located at the outer ends of two straps which are secured to the roller, is capable of pulling a patient in excess of 500 pounds. According to this aspect of the invention, the initial attachment of the connector to the sheet and the initial pulling of the sheet into the housing essentially “loads” the system, for subsequent pulling of the sheet in a weighted condition, i.e., with a patient supported thereon.

Still further, in association with this aspect of the invention, the sheet includes “loaded” indicia, to indicate (for instance, to visibly indicate) to the user when the sheet has been sufficiently pulled into the housing to achieve adequate “loading.” The sheet loading indicia can be located on either side of the sheet, and preferably is discernable through the sheet, so that the sheet can be used with either side facing upwardly. In addition, the sheet loaded indicia can be arranged or located so as to match up with, or become aligned with, corresponding mattress indicia located on the mattress. The alignment of these two corresponding sheet and mattress indicia serves to indicate when the sheet has been loaded. The Figures of this application show visible indicia, for both the sheet loaded indicia and the mattress indicia. The sheet may also include additional sheet usage indicia, to indicate the amount of sheet remaining at the foot end of the bed, and when the excess length of sheet at the foot end has been exhausted, such that it is time to replace the existing sheet with a new sheet. The sheet usage indicia may be numerical, color coded, or symbolic, as examples.

Alternatively, the controller included with the drive mechanism may include a counter which counts the number of times the sheet has been repositioned, i.e., for instance, by the number of rotations of the roller, thereby to provide an indication when the sheet needs to be replaced after a predetermined number of rotations. Still further, the housing may include a sensor, operatively connected to the controller, which is adapted to sense and to convey to the controller one or more of: the sheet loaded indicia, the sheet usage indicia, or perhaps other indicia, such as indicia to assure that a properly sized sheet, i.e., a compatible sheet, has been attached.

The mattress includes two rows of spaced retainers, for holding opposite sides of the sheet as the sheet is moved toward the head end of the mattress to reposition the patient. The use of a plurality of spaced retainers provides a significant advantage in everyday use. More specifically, in a hospital setting, there are a significant and consistent number of situations wherein a sheet must be replaced while the patient remains on the mattress of the bed. Applicants are aware of

studies which state that this occurs frequently. With the system and method described in this specification, a caregiver can secure one edge of the sheet to one side of the mattress via the retainers, then tuck the sheet underneath the patient for subsequent securement of the other edge of the sheet to the retainers on the opposite side of the mattress. When the sheet is secured in this manner, enough “slack” can be left at the head end of the sheet, as indicated by the sheet loading indicia, to enable the system to become loaded without having to pull any portion of the sheet which is supporting the patient. In other words, only the slack at the head end of the sheet is pulled. Thus, this system and method can readily accommodate the repositioning of a patient in those situations where a sheet must be replaced while the patient remains on the bed. In other words, with this system and method it is not necessary to connect both sides of the sheet at the foot end of the mattress, and to then simultaneously move both connected sides of the sheet toward the head end, along parallel continuous tracks.

According to another aspect of the invention, the retainers have a base piece secured to the mattress (or to a ticking which comprises the outer cover and surface for the mattress) and a movable piece which connects to the base piece and moves relative thereto. The movable piece moves between a closed position which defines a channel for retaining the beaded edge of the sheet, and an open position which opens the channel to allow the sheet to be released. In the closed position, the channel allows movement of the sheet toward the head end of the bed. According to yet another aspect of this invention, the pieces of the retainers have a detented position to identify when the movable piece is properly located in the closed position. The spaced retainers are located along the sides of the mattress, preferably in locations that are displaced from the rails of a conventional health care bed.

Although it is contemplated that various types of drive mechanisms would work with this system and method, one suitable drive mechanism includes a power supply, a controller, a drive train, and gears located entirely within the housing, and operable to cause the driven components, in this case a roller and two connector straps, to rotate so as to pull the sheet into the housing. The controller operatively connects to inputs mounted on the external surface of the housing, to enable a user to operate the system. Preferably, an arrestor, which could be a clutch, holds the roller in a fixed position, to thereby prevent the sheet from being pulled downwardly toward the foot end of the bed, i.e., to prevent unwinding of the sheet from the roller. With this structure, to reposition the patient the controller is enabled, as by depressing an enabling (or “start”) pushbutton, and then a reposition button is depressed to activate the drive mechanism to rotate the roller. Because of the need for a user to actively interface with two separate controls, this system and method provides a significant degree of safety in repositioning the patient. Further, to reposition the sheet towards the foot end of the mattress, or to remove the sheet, the arrestor is released which enables the roller to freewheel in a direction to allow the sheet to be pulled from the housing.

Nonetheless, other structures or components could be used, in the alternative, to supply the degree of safety needed. Still further, a safety stop device, such as a disabling sensor and/or switch, can be incorporated into the system to prevent inadvertent movement of the patient too close to the head end of the mattress, or to the headboard. It may also be desirable to incorporate a separate sensor into the system, to disable the drive mechanism unless the head end of the mattress is oriented horizontally, or at least below a predetermined angle relative to horizontal.

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Regardless of the particular drive mechanism used, when movement of the sheet toward the head end stops, the system permits reversal of the drive mechanism to permit the sheet to pull back toward the foot end of the bed. This reversal releases the tension in the sheet and enhances patient comfort.

According to another aspect of the invention, it would be possible to reduce the overall cost of the system by reducing the number of components located within the housing itself, perhaps by locating only the passive driven components within the housing and perhaps one or more components which couple to the driven components. In this respect, a separate hand held unit could be used from outside the housing to interface with the passive components, i.e., a roller, or other pulling device or sheet take-up structure located inside the housing, thereby to drive the passive components located in the housing so as to reposition the sheet and the patient residing thereon. Thus, multiple products could be operated by a single hand held unit. And for a facility with a significant number of beds, this option would reduce overall costs by eliminating the need to locate some or all of the active drive components in each housing.

At the foot end of the mattress, a barrier may be used to support and isolate the unused and remaining part of the sheet. This barrier may be connected to the mattress, the bed frame, and/or the footboard. This barrier can also serve as a spacer between the foot end of the mattress and the bed frame, typically the footboard, to provide unobstructed movement of the sheet. Alternatively, the barrier and the spacer can be separate structures.

As shown and described herein, the sheet is wider than the mattress and also wider than the housing. Nevertheless, the drive mechanism pulls the extra sheet width, on both sides, around the corners of the mattress at the head end thereof and into the housing via the slot. The contours of the housing, at the head end and at the corners, facilitate movement of the sheet toward the slot. To achieve this contoured affect, the head end of the housing may include a curved extension that extends slightly beyond the head end of the mattress. This creates a "waterfall" effect to prevent against the entry of foreign objects into the slot. This extension can also serve as the head end boundary for the head end of the mattress, and also reduces compression of the head end of the mattress.

The transverse dimension of the slot needs to be able to accommodate some amount of sheet overlap, or doubling over of the sheet, near the outer ends. Moreover, within the housing itself, the roller may have a reduced diameter at its outer ends, thereby to provide additional internal clearance within the housing to accommodate this extra sheet width. Nonetheless, the width of the slot is still sufficiently small, i.e., preferably about 8 mm, to prevent the accidental ingress into the housing of a user's finger or medical tubes or wires. Additionally, a safety cut-off switch may be incorporated into the system, particularly to disable the drive mechanism, so as to discontinue rotation of the roller upon detection of a higher than normal resistance.

The mattress has a head end section of reduced thickness, and is complementary in shape with the housing, at least with respect to a central longitudinal vertical plane. The head end section may contain a foldable head end piece defined by a fold line, and foldable about the fold line to access the housing. Alternatively, the head end piece could be removably connected to the mattress along the "fold line." The head end section of the mattress may be firmer than the rest of the mattress, to further protect a patient from the housing residing therebelow. An increased firmness of the head section may also increase the wear resistance of the head end section as the sheet is pulled over the edge of the mattress. To further protect

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against mattress head section wear, a portion of the housing is adjacent the head end of the mattress to limit the compressibility of the mattress as the sheet is advanced. In an alternative embodiment, the mattress head section does not have a reduced thickness. Instead, the housing is integrated into the head section of the bed deck. In this embodiment, the access door of the housing may be incorporated into the bed deck.

With this patient repositioning system, according to the preferred embodiments, the structure which pulls the sheet does not contact or interact with the bed frame or the headboard of the bed. Instead, because of the complementary shape of the mattress and the housing, the system primarily operates within the space envelope of the mattress. Preferably, the housing is removably mounted to the deck of the bed, thereby to assure its physical position relative to the mattress during articulation of the bed into various positions. Regardless of the position of the deck, the housing can be accessed by moving the head end piece of the mattress. Additionally, because the hinged access door partially defines the slot in this embodiment, this structure simplifies the proper routing and/or orienting of the connectors, namely the straps, prior to their releasable attachment to the sheet. Overall, this structure helps to assure a safe, simple, efficient, user-friendly, and repeatable attachment of the sheet to the drive mechanism. This structure also facilitates the user's ability to practice effective infection control.

The system and method disclosed herein is not limited to use with a conventional health care bed having a flat deck. Rather, this invention may be readily adaptable for use in combination with a type of hospital bed known as a "step-deck" bed, as shown in U.S. Pat. No. 5,692,256, a birthing bed which is specifically adapted for use when a mother gives birth to an infant, or even with a bariatric bed. For these variations of the invention, the mattress and the housing are reoriented and/or reconfigured to accommodate the different bed shapes, and particularly the different shapes of the deck and/or the mattress. With these various bed designs, the patient repositioning system may be integrated at least partially into the bed deck.

Those skilled in the art will more readily understand the scope and content of this specification in view of the following drawings and the detailed description of those drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1A is a side view of a patient repositioning system for use with a health care bed, according to one exemplary, preferred embodiment of the invention.

FIG. 1B is the side view of the patient repositioning system shown in FIG. 1A, with a patient residing on the health care bed near the foot end.

FIG. 1C is the side view similar to FIG. 1B, but with the patient residing near the head end.

FIG. 2 is a perspective view of a mattress complementarily positioned against a sheet receiver, and more particularly the housing, according to the embodiment shown in FIG. 1A.

FIG. 3A is an enlarged perspective view of the mattress and the sheet receiver shown in FIG. 2, at the head end of the mattress.

FIG. 3B is an enlarged perspective view which shows the mattress complementarily positioned against the sheet receiver, with the sheet receiver attached to the health care bed as shown in FIG. 1A, with a sheet on the mattress, and with connecting structure extending out of the sheet receiver.

FIG. 3C is an enlarged perspective view, similar to FIG. 3B, showing the connecting structure positioned adjacent the sheet.

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FIG. 3D is an enlarged perspective view, generally similar to FIGS. 3B and 3C, but directed to one corner of the overall system, and showing the connecting structure releasably attached to the sheet.

FIG. 3E is an enlarged perspective view, similar to FIG. 3D, showing the sheet as it is pulled into the sheet receiver.

FIG. 4A is a perspective view of a retainer used for retaining a longitudinal edge of the sheet, with the retainer in an open position.

FIG. 4B is a perspective view, similar to FIG. 4A, with the retainer in a closed position.

FIG. 5 is a schematic cross sectional view taken along lines 5-5 of FIG. 4B.

FIG. 6 is the enlarged perspective view, similar to FIGS. 3A and 3B, showing a head end piece of the mattress folded and an access door of the sheet receiver in an open position.

FIG. 7A is a schematic cross sectional view of the sheet receiver and the head end piece of the mattress shown in FIG. 6, with the connecting structure extending out of the sheet receiver and the access door open.

FIG. 7B is a schematic cross sectional view, similar to FIG. 7A, with the access door of the sheet receiver in a closed position, the connecting structure extending upwardly, and a sheet located above the surface of the mattress.

FIG. 7C is a schematic cross sectional view, similar to FIG. 7B, with the sheet attached and ready to be pulled into the housing.

FIG. 8 is a schematic cross sectional view, similar to FIG. 7A, showing another embodiment of a portion of a suitable drive mechanism that may be used with the patient repositioning system of this invention.

FIG. 9 is an exploded view of the sheet receiver shown in FIG. 1A.

FIG. 10 is a perspective view of the sheet receiver shown in FIG. 9.

FIG. 11 is a top view of the sheet receiver that is shown in FIGS. 9 and 10, with the top panel removed.

FIG. 12 is a top view of a sheet according to the embodiment shown in FIG. 1A.

FIG. 13A is a schematic cross sectional view of an alternative embodiment of the retainer, namely a slide retainer in an open position.

FIG. 13B is a schematic cross sectional view of the slide retainer shown in FIG. 13A, in a closed position.

FIG. 14A is a schematic cross sectional view of yet another embodiment of a retainer, namely a pivot retainer, in an open position.

FIG. 14B is a schematic cross sectional view of the pivot retainer shown in FIG. 14A, in a closed position.

FIGS. 15A and 15B are schematic cross sectional views of still another embodiment of a retainer, in this case a clip retainer.

FIGS. 16A, 16B, and 16C are schematic cross sectional views of yet another embodiment of a retainer, in this case a rigid retainer which retains a compressible bead located at the edge of a sheet.

FIG. 17 is an enlarged perspective view which shows another aspect of the patient repositioning system of this invention, namely a hand held unit capable of driving the pulling device from outside the sheet receiver.

FIG. 18 is a side view of a first preferred embodiment of the sheet receiver.

FIG. 19 is a perspective view, from the inside of the sheet receiver and looking outwardly, which shows some details of a latch mechanism for the access door.

FIG. 20 is an enlarged perspective view that is analogous to the views of FIGS. 3B and 3C, but showing an alternative

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embodiment, with the sheet receiver integrated with a portion of a bed deck, so that the top of the sheet receiver is contiguous with the top of the bed deck.

FIG. 21 is a block diagram which schematically shows a control system for communicating with the various components of a patient repositioning system of the type shown and described herein.

DETAILED DESCRIPTION OF THE DRAWINGS

With reference to FIG. 1A, an embodiment of a patient repositioning system 10 for use with a health care bed 12, such as a hospital bed, includes a mattress 14, a sheet 16, and a sheet receiver 18. As noted previously, the sheet receiver generally encompasses a housing and a drive mechanism. The exemplary health care bed 12 is more particularly an articulating bed commonly used in hospitals, nursing homes, private homes, or any other environment where patient care is enhanced through the use of the articulating bed. Common articulating beds, such as the health care bed 12, include a frame 20 for supporting a bed deck 22 above a floor 24. According to the exemplary embodiment, the frame 20 also includes a plurality of wheels 26 to more easily move the health care bed 12 in preparation of or during patient care. The health care bed 12 also includes a headboard 28 and footboard 29 each removably attached to a respective head end 30 and foot end 31 of the health care bed 12. With respect to the use of the terms "head" or "head end" and "foot" or "foot end," it will be appreciated that such directions are intended to describe relative locations along exemplary embodiments of the patient repositioning system 10 positioned along the health care bed 12. It is not intended that the terms "head end" and "proximal end" limit the invention to any of the exemplary embodiments described herein.

The sheet receiver 18, mattress 14, and sheet 16 are each positioned adjacent to the bed deck 22 as shown in FIG. 1A. More particularly, the bed deck 22 includes a head deck portion 32, a central deck portion 34, and a foot deck portion 36. Each of the head deck, central deck, and foot deck portions 32, 34, 36 are pivotably connected together for use as the articulating bed. The mattress 14 rests directly upon the bed deck 22 similar to a traditional mattress. However, unlike a traditional mattress, the sheet receiver 18 is secured to the head deck portion 32 below a portion of the mattress 14, while the sheet 16 may be partially stowed between the mattress 14 and the footboard 29. FIG. 1A shows the sheet receiver 18 entirely below a top surface of the mattress 14. But in the context of this specification "below" means at least in part below, as in at least in part below the top surface of the mattress. The sheet receiver 18 also releasably attaches to the mattress 14 for reducing the likelihood of inadvertent relative movement therebetween. For example, the sheet receiver mattress 14 may attach to the mattress 14 via cooperating structures such as hook and loop fasteners, snaps, magnets or any other structure for releasably attaching one surface to another. According to the exemplary embodiment, a barrier 38 attaches to the frame 20 below the foot deck portion 36 and extends toward the footboard 29. Accordingly, the barrier 38 supports at least a portion of the sheet 16 resting between the mattress 14 and the footboard 29. While the health care bed 12 may be the articulating bed shown in the exemplary embodiment, it will be appreciated that the patient repositioning system 10 may also be used with other beds, such as stepped deck beds and birthing beds, which will be described below in further detail.

As indicated by arrow 40 in FIG. 1A, the sheet 16 is pulled onto an upper surface 110 of the mattress 14 from a mattress

foot end 112 to a mattress head end 114, where the sheet 16 feeds into the sheet receiver 18. More particularly with respect to FIG. 1B, a beaded edge 510a on a sheet longitudinal side 512a is slidably positioned within a row of retainers 116. The row of retainers 116 is located along a mattress longitudinal side 118a for guiding the sheet 16 between the mattress foot and head ends 112, 114. The retainers 116, described further below, may be spaced along the mattress 14 in generally any orientation that both holds the sheet 16 and allows for operator access to the retainers around various components of the health care bed 12. The sheet 16 is similarly received by another row of retainers (not shown) on an opposing mattress longitudinal side 118b (see FIG. 2).

A patient is shown in FIG. 1B resting on the sheet 16 in a foot end position after having migrated from a head end position. Generally, the term “head end position” refers to a preferred patient position closer to the mattress head end 114 than the mattress foot end 112. Similarly, the term “foot end position” generally refers to any position of the patient after migrating from the mattress head end 114 toward the mattress foot end 112. It will be appreciated, however, that the terms head end position and foot end position are merely exemplary and intended to show distinguishing positions in which to move the patient. As such, the invention is not intended to be limited to the head and foot end positions shown.

An operator, such as a caregiver or an attendant, may desire to return the patient to the head end position. Frequently, moving the patient from the foot end position to the head end position may require manually gripping and pulling a sheet, on which the patient rests, toward the headboard 28. However, the patient repositioning system 10 automatically repositions the patient to the head end position under direction by the operator. According to the exemplary embodiment, the operator enables the patient repositioning device 10 by activating an enabling switch 210 operatively connected to the sheet receiver 18. Once enabled, the operator then activates a drive switch 212 operatively connected to the sheet receiver 18. With both the enabling switch 210 and drive switch 212 activating, the sheet receiver 18 pulls the sheet along the upper surface 110 toward the head board 28, as indicated by arrows 42. Because the patient is resting on the sheet 16 as it moves, the patient similarly moves away from the footboard 29 and toward the headboard 28, as indicated by arrow 42. The patient is moved toward the headboard 28 until reaching the desired head end position shown in FIG. 1C. Of course, in the event that the patient again migrates toward the foot end position, the operator may repeat the operation of repositioning the patient with the patient repositioning system 10 as desired.

With respect to FIG. 2, the mattress 14 for repositioning the patient generally includes the mattress foot end 112, the mattress head end 114, the upper surface 110, and the pair of longitudinal sides 118a, 118b as described above. Generally, the pair of longitudinal sides 118a, 118b is symmetric with a generally uniform thickness, while the upper surface 110 has a substantially uniform width and length. The mattress 14 is also covered in an outer ticking 120 for effectively improving the life and comfort of the mattress 14. In addition, each of the retainers 116 is attached to the outer ticking 120 of the mattress 14 in spaced relation along the length of the mattress longitudinal sides 118a, 118b. However, the mattress head end 114 also includes a head end section 122 of reduced thickness relative to the generally uniform thickness of the remaining mattress 14. In this respect, the head end section 122 is a relatively thin portion of the mattress 14 and further includes a head end piece 124. The head end piece 124 folds about a fold line 126 relative to the rest of the mattress 14 for

improving access to the sheet receiver 18 below the upper surface 110 of the mattress head end 114. Further details concerning access to the sheet receiver 18 will be further discussed below with respect to FIG. 6. However, it will be appreciated that other respective portions of the mattress 14 may be otherwise movable for accessing the sheet receiver 18.

Furthermore, at least a portion of the sheet receiver 18 is positioned within a volume envelope 128 (see FIG. 7B) of the mattress 14 for effectively reducing an overall footprint of the mattress 14 and sheet receiver 18. The reduced thickness of the head end section 122 has a lower surface 130 and a forward surface 131 that collectively define the volume envelope 128 that would otherwise be occupied by the mattress 14 if not for the head end section 122 of reduced thickness. Thereby, the head end section 122 is complementary in shape to a housing 214 of the sheet receiver 18.

As best shown in FIGS. 7A-7C and according to an exemplary embodiment of the invention, the housing 214 at least partially fits within the volume envelope 128 against the lower surface 130 and the forward surface 131 of the head end section 122. The housing 214 has a length substantially the same as the width of the mattress 14 and includes a slot 216 extending horizontally along the length of the housing 214. Additionally, the housing 214 includes an extension 218 protruding horizontally along the length of the housing 214 and above the slot 216. According to an exemplary embodiment of the invention, the extension 218 defines a lip 220 against which the head end piece 124 abuts when the sheet receiver 18 is positioned within the volume envelope 128.

FIG. 3A shows additional detail of the relative positions between the mattress 14 and the housing 214 and greater detail of the outer ticking 120. Specifically, the outer ticking 120 is formed from a comfort material 132, a durable material 134, and a stiff material 136. In this respect the comfort material 132 forms a portion of the outer ticking 120 suitable for comfortably supporting and contacting the patient, directly or indirectly. Meanwhile, the durable material 134 and the stiff material 136 form respective portions of the outer ticking 120 that increase life and durability of the mattress 14 where patient comfort is of less concern. On one hand, the durable material 134 also provides sufficient structure for attaching the retainers 116. The exemplary retainers 116 are welded to the durable material 134, but other structures and methods, such as adhesive, snaps, fasteners, or stitching, may similarly be used to attach the retainers 116 to the durable material 134. On the other hand, the stiff material 136 also provides reduced elasticity and reduced friction where components of the sheet 16 and/or sheet receiver 18 may frictionally engage the mattress 14. In this respect, the head end section 122 is relatively firmer than the rest of the mattress to support pulling the sheet 16 about the head end edge 140 as shown in FIGS. 3A-3D. While the nomenclature “comfort,” “durable,” and “firm” each relatively describe various features of the outer ticking 120, it will be appreciated that these features are not intended to be limited solely to these material types. Rather, the exemplary embodiment merely shows one combination of known materials for producing an outer ticking 120 with properties sufficient for use with the patient repositioning system 10.

With respect to FIGS. 3A and 3B, the durable material 134 is stitched to the comfort material 132 at a seam 138 extending along the mattress longitudinal sides 118a, 118b. Also, a head end edge 140 of the mattress head end 114 includes the stiff material 136 that extends along at least a portion of the head end piece 124. The stiff material 136 is attached directly onto the comfort material 132 and provides a surface of

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reduced elasticity about which the sheet receiver **18** may pull the sheet **16**. In the alternative to stitching and/or gluing the outer ticking **120** together, the comfort, durable, and stiff materials **132**, **134**, **136** may be similarly welded to improve sealing and reduce the likelihood of fluids, such as bodily 5 contaminants, from permeating into the mattress **14**. However, it will be appreciated that any known method of connecting materials together to foam the outer ticking **120** may be used in accordance with the invention.

The sheet receiver **18** has a slot **216**, and also includes a 10 connecting structure **222** for releasably attaching to the sheet **16** adjacent to the mattress head end **114**. The connecting structure **222** is generally of a sufficiently small dimension so as to pass through the slot **216** and toward the sheet **16**, which may also be referred to herein as a “low-profile” connecting structure **222**. According to the exemplary embodiment of the invention, the connecting structure **222** is a pair of straps **224a**, **224b**. Each of the straps **224a**, **224b** includes a first end **226** secured within the housing **214** and a second end **228** for releasably attaching to the sheet **16**. Accordingly, the operator 20 extends the pair of straps **224a**, **224b** about the head end edge **140** and pulls the sheet **16** along the upper surface **110** of the mattress **14**, as indicated by arrow **44**. The sheet head end **516** and the second end **228** each move adjacent to the mattress head end **114** as shown in FIG. 3C. Thus, in order to releasably attach the pair of straps **224a**, **224b**, each of the second ends **228** includes a T-shaped tab **230** that cooperates with at least one of a pair of reinforced slits **514a**, **514b** formed in a sheet head end **516**. Notably, the width of the sheet **16** is generally wider than the upper surface **110** such that the beaded edge **510a** rests along the mattress longitudinal side **118a** and adjacent to the row of retainers **116**. While an exemplary embodiment of the invention includes the connecting structure **222** as a pair of straps **224a**, **224b**, it will be appreciated that other forms of connecting structures for connecting the sheet **16** to the remainder of the sheet receiver **18** may also be used. By way of example, the connecting structure **222** may be any number of straps, such as one strap, that may be separate or unitary for pulling the sheet **16**.

FIG. 3C and FIG. 3D show that each of the pair of slits **514a**, **514b** are spaced apart from one another and generally parallel for receiving the T-shaped tab **230**. In addition, each of the retainers **116** operatively hold the beaded edge **510a** for guiding movement of the sheet **16**. More particularly, each of the straps **124a**, **124b** withdraw through the slot **216** and into the housing **214**, as indicated by arrow **46**, to simultaneously pull the sheet **16** along the upper surface **110**, as indicated by arrow **48**. However, in the event that an external force halts, or otherwise impedes the movement **46** of the sheet **16**, the tab **230** releases from the pair of slits **514a**, **514b** for preventing damage to the sheet **16** and/or sheet receiver **18**.

As can be more clearly seen in FIG. 3D and FIG. 3E, the sheet **16** continues to move toward the mattress head end **114**, about the head end edge **140**, and toward the sheet receiver **18** until being pulled into the slot **216** and within the housing **214**, as indicated respectively by arrows **48**, **50**, and **52**. The sheet receiver **18** generally pulls the sheet **16** until a sufficient amount of sheet **16** collects within the housing **214** to fixedly attach the sheet **16** to the sheet receiver **18**. According to an exemplary embodiment, the mattress longitudinal side **118a** includes an alignment sheet indicia **144**, and the sheet **16** includes a sheet loaded indicia **518**. Once sheet loaded indicia **518** moves into alignment with the alignment sheet indicia **144**, the pair of indicia **144**, **518** cooperatively indicate to the operator, for instance by visual alignment, that the sheet **16** is engagingly attached to the sheet receiver **18**, i.e. it is “loaded.” Because the sheet **16** is engagingly attached, the sheet **16** may

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be used to pull both the sheet **16** and the patient (see FIG. 1B). To brace the sheet receiver **18** while pulling the patient, the sheet receiver **18** also includes a pair of mounting brackets **232a**, **232b** for mounting the sheet receiver directly to the head deck portion **32** below the head end section **122**. However, it will be appreciated that the sheet receiver **18** may be attached to the bed via one of any number of different structures.

FIG. 3D and FIGS. 4A-5 show an exemplary embodiment of the retainer **116** having a base piece **410** and a movable piece **412**. The retainer **116** secures to the mattress **14** by welding the base piece **410** directly to the durable material **134** of the outer ticking **120**. In contrast, the movable piece **412** connects to the base piece **410** or otherwise projects from the base piece **410**. Notably, the movable piece **412** moves relative to the base piece **410** between an open position and a closed position for defining a channel **414** therebetween. The base piece **410** is generally planar and relatively thin for providing sufficient surface area to both weld to the outer ticking **120** and connect the movable piece **412**. However, the base piece **410** also includes a horizontally extending base projection **416** having a base curved portion **418** and a base planar portion **420**. The movable piece **412** similarly includes a horizontally extending projection **422** having a curved portion **424** and a planar portion **426**. Thus, while in the closed position, the base curved portion **418** of the base piece **410** aligns with the curved portion **424** of the movable piece **412** to define the channel **414** for retaining the beaded edge **510a**. Also, the base planar portion **420** aligns with the planar portion **426** to define a gap **428** therebetween for allowing the remaining sheet longitudinal side **512a** to extend toward the upper surface **110** of the mattress **14**.

In the open position shown in FIG. 4A, the open channel **414** facilitates the insertion of the beaded edge **510a** into the channel **414** and/or the removal of the beaded edge **510a** from the channel **414**. To retain the sheet **16**, the movable piece **412** is rotated, or otherwise moved, as indicated by arrow **54**, to the closed position. The closed position retainer **116** is shown in FIG. 4B and FIG. 5. On one hand, the closed channel **414** has a diameter generally larger than the beaded edge **510a** for allowing the beaded edge **510a** to slide along the channel while being pulled, as indicated by arrow **56**. On the other hand, the gap **428** has a width that is generally smaller than the beaded edge **510a** for retaining the beaded edge **510a** within the channel **414**.

Furthermore, the base and movable pieces **410**, **412** each cooperate together with a detented surface relationship to affirmatively indicate when the movable piece is in the closed position. More particularly, the base piece **410** includes a horizontally extending detent **430**, and the movable piece **412** includes a horizontally extending groove **432** adapted to receive the detent **430**. For example, the movable piece **412** rotates against the direction of the pull **56** to open the channel **414**. The movable piece **412** may then be rotated back **54** along the direction of the pull **56**, as seen in FIG. 4A, to “snap” the detent **430** into the groove **432** to achieve the closed position in FIG. 4B. However, according to the exemplary embodiment, the movable piece **412** ceases to rotate **54** beyond the snap of the detent **430** and the groove **432**. As such, foreseeable drag of the sheet **16** within the retainer **116** during the pull **54** will not unintentionally open the retainer **116** and release the sheet **16**.

Greater detail of the rotational mounting of the movable piece **412** to the base piece **410** is shown in FIG. 5. First, the base piece **410** includes a face plate **434** for welding to the durable material **134** of the mattress **14** and abutting the movable piece **412**. Second, the base piece **410** also includes

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a back plate **436** within a mattress foam **146** for mounting a fastener **438**. A hole **440** extends through the back plate **436**, the face plate **434**, and into the movable piece **412**. The hole **440** receives the fastener **438** for assembly of the retainer **116** and for rotatably mounting the movable piece **412** to the base piece **410**. Thus, if the movable piece **412** requires any repair, the movable piece **412** may simply be removed from against the base piece **410** and a replacement movable piece **412** threaded back onto the fastener **438**. However, it will be appreciated that the movable piece **412** and the base piece **410** may be movable relative to each other via a living hinge extending therebetween, or similar unitary structure.

While the exemplary embodiment of the retainer **116** is configured for retaining the sheet **16** as described above, it will be appreciated that other retainers in accordance with the invention may also be used. For exemplary purposes, additional retainers **116** for retaining the sheet **16** are described below with respect to FIGS. **13A-15E**. In any case, the retainer **116** is not intended to be limited these exemplary embodiments described herein.

After the unused sheet **16** has been exhausted, the sheet **16** may be removed from the retainers **116** and sheet receiver **18** for cleaning the patient repositioning system **10** as shown in FIG. **1C** and FIG. **6**. Each of the retainers **116** opens at the operator's discretion for removing the sheet **16** therefrom. The sheet receiver **18** includes a sheet release **234** that may be operatively activated by the operator so that the sheet **16** may be removed from the housing **214**. During patient use, the sheet **16** may become contaminated and advance into the sheet receiver **18**, which, in turn, contaminates the sheet receiver **18**. Thus, the sheet receiver **18** opens to provide cleaning access during and/or between patient uses as shown in FIG. **6**.

With respect to FIG. **6**, the housing **214** of sheet receiver **18** includes an access door **236** adjacent a top panel **238**. The head end piece **124** folds back at the fold line **126** to expose the access door **236** that hingedly connects to the housing **214**. As such, the operator may move the access door **236** by pivoting it up and against the mattress **14** to open the sheet receiver **18** as shown in FIG. **6**. However, it will be appreciated that the access door **236** may be movable in any way relative to the remainder of the sheet receiver **18** to open the sheet receiver. For example, the access door **236** may be unitary with or connected to the head end piece **124** such that folding back the head end piece **124** simultaneously opens the access door **236**. The access door **236** opens at the slot **216** for reducing the number of openings into the housing **214**. The open sheet receiver **18** exposes each of the components within a sheet chamber **240** defined by the housing **214**. The sheet chamber **240** includes a portion of the sheet receiver **18** that may that interact with the sheet **16** (see FIG. **1C**), and thus, may require periodic cleaning by the operator. It will be appreciated that maintaining cleanliness within patient care environments, such as hospitals, nursing homes, and even private homes, critically enhances patient outcomes. For this reason, accessibility within the sheet chamber **240** provides an opportunity for the operator to simply and completely clean the sheet receiver **18** and proves particularly beneficial over the prior art described above. For example, portions of the sheet receiver **18** within the sheet chamber **240** are positioned relative to each other in order to provide enough clearance for operator cleaning and hand access for maintenance. According to an exemplary embodiment, the portions of the sheet receiver **18** within the chamber **240** provide at least generally 12 mm of clearance space therebetween.

In this respect, the sheet receiver **18** further includes a pulling device **242** operatively connected to the connecting

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structure **222** that operatively pulls the sheet **16** into the sheet chamber **240**. More specifically, the pulling device **242** includes a roller **244** rotatably and removably supported within the sheet chamber **240** and generally parallel to the slot **216**. The roller **244** includes a central portion **246** and opposing outer portions **248**. Each first end **228** of the pair of straps **224a**, **224b** is secured to the central portion **246** of the roller **244** via at least one fastener **245**. According to the exemplary embodiment of the invention, the fastener **245** is threaded and extends through the first end **228** and into the roller **244**. Of course, it will be appreciated that any structure or method of securing the straps **224a**, **224b** to the roller **244** may be similarly used.

With respect to FIG. **1B**, FIG. **3E**, and FIG. **6**, as the pulling device **242** pulls the sheet **16** into the sheet chamber **240**, the sheet **16** is pulled to wrap about the roller **244**. According to the exemplary embodiment of the invention, engaged attachment of the sheet **16** to the sheet receiver **18** occurs when the sheet **16** sufficiently wraps around the roller **244** to transmit enough torque from the roller **244** to the sheet **16** with enough force to pull the patient. More particularly, the central portion **246** is generally larger in diameter than the opposing outer portions **248**. On one hand, the larger diameter of the central portion **246** transmits torque to the sheet **16** while pulling both the sheet **16** and the patient resting thereon. On the other hand, the reduced diameter of the opposing outer portions **248** accommodates the excess width of the sheet **16** for both the sheet longitudinal sides **512a**, **512b** and the beaded edges **510a**, **510b** during use. As such, most of the force required to pull the patient transmits through the portion of the sheet **16** on the upper surface **110** and about the head end section **122** of the mattress **14**, while less force transmits through the sheet longitudinal sides **512a**, **512b**.

While the sheet **16** may be pulled by and wrapped about the roller **244** shown in FIG. **6**, the sheet **16** may alternatively be pulled by other mechanisms for pulling sheets. Another exemplary embodiment may use two or more abutting rollers in the form of a roller press (not shown) for engaging and pulling a sheet. According to yet another exemplary embodiment, one or more rollers may also be placed against another type of surface for engaging and pulling the sheet. Thus, the pulling device **242** is not necessarily intended to be limited to the roller **244** wrapping the sheet **16** as described herein.

In any case, a drive mechanism **252** operatively drives the pulling device **242** for pulling the sheet **16** along the upper surface **110** of the mattress **14**. FIGS. **7A** and **7B** show a gear drive portion **253** of the drive mechanism **252** including a drive gear **254**, an idler gear **256**, and a driven gear **258**. The drive gear **254** is actively rotated by the remaining portion of the drive mechanism **252** described below in further detail with respect to FIG. **11**. The drive gear **254** engages the idler gear **256**, which, in turn, engages the driven gear **258**. Thus, as the drive gear **254** actively rotates, the idler gear **256** and driven gear **258** passively rotate in response. Finally, the driven gear **258** connects to the roller **244** such that, as the driven gear **258** rotates, the roller **244** rotates in turn.

According to an exemplary embodiment of the invention shown in FIG. **3E** and FIGS. **7A-7C**, the driven gear **258** in conjunction with the sheet release **234** also functions as an arrestor **260** for both restricting rotation of the roller **244** and releasing the rotation of the roller **244**. Restricting rotation of the roller **244** operatively holds the sheet **16** in place so as to prevent movement of the sheet **16** toward the mattress foot end **112** (see FIG. **1B**), while releasing the roller **244** enables repositioning or unwrapping of the sheet **16** from the roller **244**. To restrict rotation of the roller **244**, the remaining portion of the drive mechanism **252** engages the drive gear **254**

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rigidly against the idler gear **256** when not actively rotating the driven gear **258**. However, the drive gear **254** selectively moves via the sheet release **234** to disengage the idler gear **256** and release the rotation of the roller **244**, as indicated by arrow **262**. Thus, the driven gear **258**, the idler gear **256**, and the roller **244** may freely rotate, or “freewheel,” when the drive gear **254** disengages from the idler gear **256**. In the alternative, the drive mechanism **252** may actively reverse under power to release the sheet **16**. In another alternative, the arrestor **260** may be a brake or similar mechanism for halting the drive mechanism **252** and/or roller **244**.

FIGS. 7A-7C show the access door **236** in both an open and closed position, respectively. The housing **214** further includes a hinge **264** attached between the access door **236** and the remainder of the top panel **238** for pivoting, or otherwise moving, the access door **236** between open and closed positions. The hinge **264** may also include damping or drive-assisted movement for enhanced performance between the open and closed positions.

In the closed position of FIGS. 7B-7C, the head end piece **124** of the mattress **14** conforms to both the hinge **264** and the lip **220** of the extension **218**. The access door **236** opens and closes at the slot **216**, which is defined by the extension **218** of the access door **236** and a front panel **272** of the housing **214**. Notably, the slot **216** essentially expands into the open sheet chamber **240** when the access door **236** pivots upward toward the head end section **122** of the mattress **14** so that slot **216** and the sheet chamber **240** share a common opening. By reducing the number of openings through the housing **214** and into the sheet chamber **240**, the pair of straps **224a**, **224b** may only extend through the housing **214** at the slot **216**. In turn, the likelihood of the operator inadvertently extending the pair of straps **224a**, **224b** through an incorrect opening is similarly reduced while still providing ample access for the operator to clean within the sheet chamber **240**.

With the access door **236** closed, the slot **216** has a transverse dimension large enough for receiving the pair of straps **224a**, **224b** and sheet **16**, but small enough for inhibiting a human finger or other foreign object from extending therethrough. Particularly, the transverse dimension may be from about 4 millimeters to about 12 millimeters. More particularly, the transverse dimension may be less than about 8 millimeters. Furthermore, the extension **218** of the access door **236** preferably includes a “waterfall” lip **274** secured to the remaining portion of the access door **236**. FIG. 7 and FIG. 3D taken together more clearly show that the waterfall lip **274** is curved for smoothly guiding the pair of straps **224a**, **224b** and sheet **16** into the slot **216**. Similarly, the extension **218** includes a pair of contoured corners **275a**, **275b** further defining the slot **216** for smoothly guiding the sheet longitudinal sides **512a**, **512b** into the slot **216**. Together, the waterfall lip **274** and contoured corners **275a**, **275b** reduce the likelihood of sheet stress and sheet snags while helping to maintain the sheet longitudinal sides **512a**, **512b** along the mattress longitudinal sides **118a**, **118b** by retaining the head end position of the beaded edges **510a**, **510b** being pulled into the slot **216**, respectively. On the other hand, the waterfall lip **274** also projects outward beyond the front panel **272** for inhibiting foreign matter that lays or falls nearby from entering the slot **216** unintentionally. For example and with respect to both FIG. 1C and FIG. 7B, contaminants from the patient or tubing required for patient care may fall over the mattress head end **114** and against the sheet receiver **18** near the slot **216**. However, the waterfall lip **274** decreases the likelihood of the tubing or contaminants from entering the slot **216** by directing such foreign matter outward from both the slot **216** and the front panel **272**.

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Furthermore, term “low-profile” with respect to the connecting structure **222** may be further defined as having the sufficiently small dimension generally less than the transverse dimension of the slot **216** for pass therethrough. Preferably, the “low-profile” connecting structure **222** has the sufficiently small dimension configured for also reducing the amount of sheet **16** deformation resulting from wrapping the sheet **16** over the connecting structure **222** on the roller **244**. After all, localized deformation of the sheet **16** tends create wear patterns that may prematurely tear portions of the sheet **16**. However, the “low-profile” connecting structure **222**, such as the straps **224a**, **224b**, serves to enhance and extend the useful life of the sheet **16**.

With respect to FIG. 7C, the extension **218** rigidly guides the sheet **16** and the straps **224a**, **224b** about the extension **218** and into the slot **216**. In contrast, the head end piece **124** is relatively softer than the extension **218** for enhancing patient comfort. As such, the straps **224a**, **224b** and sheet **16** tend to compress the head end piece **124** while being pulled into the sheet receiver **18** and, in turn, hold the sheet **16** in excess tension. In response, once the roller **244** rotates to reposition the patient, the driven gear **258** reverses for a predetermined period time to reverse the wrapping of the sheet **16** about the roller **244**. The predetermined period of time is generally long enough to release the excess tension in the sheet head end **516**, but short enough to prevent the sheet **16** from becoming loosely held by the sheet receiver **16**. As such, the sheet **16** remains slightly taut while allowing the head end piece **124** to return to form as shown in FIG. 7C. Alternatively, the roller **244** may operatively disengage from the drive unit, such as via a clutch **276a** (see FIG. 8), to allow the roller **244** to freewheel for the predetermined period of time/

FIG. 8 shows an alternative chain drive portion **277** driven by a motor **276b** connected to a clutch **276** for rotating the roller **244** in which like numbers indicate like features described above. The chain drive portion **277** includes a chain drive gear **278** operatively connected to the clutch **276** and chain driven gear **280**. Rather than pivot the chain drive gear **278** for operatively disengaging the roller **244** as described above, the clutch **276** selectively engages the chain driven gear **280**. In this way, the motor **276b** may either rotate the roller **244** or allow the roller **244** to freewheel as described above so that the clutch **276a** acts as the arrestor **260** (see FIG. 7C). In addition, a chain **281** simultaneously wraps about the chain drive gear **278** and the chain drive gear **280** such that the actively driven chain drive gear **278** drives the chain driven gear **280** via the moving chain **281**. Accordingly, the roller **244** may rotate for pulling the sheet **16** as described above. However, it will be appreciated that the other combination of drive components, such as gears, chains, sprockets, and/or belts, may be used to operatively rotate the roller **244**.

FIGS. 9-11 show further details of the sheet receiver **18** removed from the volume envelope **128** (see FIG. 7C) of the mattress **14**. The housing **214** includes the top and front panels **238**, **272** described above and also a pair of side panels **282a**, **282b**, a rear panel **284**, and a bottom panel **286**. Furthermore, the housing **214** has a housing frame **288** that includes a pair of lateral support members **290a**, **290b** and a central cross member **291**. The central cross member **291** extends perpendicularly between the pair of lateral support member **290a**, **290b** and divides space within the housing **214** into the sheet chamber **240** and a drive chamber **292**. The members **290a**, **290b**, **291**, **290a**, **290b** may also be rounded to facilitate cleaning within the sheet chamber **292**. More particularly, the sheet chamber **240** is defined by the top panel **236**, the support members **290a**, **290b**, the bottom panel **286**, and the front panel **272**. Also, the drive chamber **292** is

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defined by the top panel **238**, the support members **290a**, **290b**, the bottom panel **286**, and the rear panel **284**.

The drive chamber **292** generally includes the remaining portion of the drive mechanism **252**. According to the exemplary embodiment, the drive mechanism **252** also includes a power source **294**, a controller **294a**, a sheet release sensor **296**, a door sensor **298**, and a motor **300**. The motor **300** directly connects to the drive gear **254** for selectively rotating the drive gear **254**. In addition, the pair of lateral support members **290a**, **290b** rotatably supports a sheet release rod **302** within the drive chamber **292**. The motor **300** connects to the rotatable sheet release rod **302**, which extends through the side panels **282a**, **282b** to each of the sheet releases **234**. At the operator's discretion, movement of the sheet release **234** pivots the motor **300** about the sheet release rod **302**. In turn, the drive gear **254** directly connected to the motor **300** pivots, as indicated by arrow **262** in FIG. 7A, for operating the sheet release **234**.

With respect to FIG. 11 and FIG. 1B, the controller **294a** electrically connects to the motor **300**, the sheet release sensor **296**, the door sensor **298**, the enabling switch **210**, and the drive switch **212** for operating the sheet receiver **18**. The controller **294a** also connects to a power source **294** via a power cord **306** for powering the drive mechanism **252**. As described above, the enabling switch **210** and drive switch **212** cooperate for directing the controller **294a** to power the motor **300**, rotate the drive gear **254**, and effectively pull the sheet **16**. However, the sheet release sensor **296** and door sensor **298** are configured for preventing powering the motor **300** for movement while either sheet release **234** is active or the access door **236** is open, respectively. For example, rotating the sheet release rod **302** via the sheet release **234** moves a sheet release cam **304** that operatively engages the sheet release sensor **296**. The engaged sheet release sensor **296** then operatively prevents the controller **294a** from operating the motor **300**. Similarly, the door sensor **298** is configured to selectively engage a door projection **308** attached to the access door **236** (see FIG. 6). On one hand, when the access door **236** closes, the door projection **308** engages the door sensor **298** for indicating the closed access door **236** to the controller **294a**. On the other hand, when the access door **236** opens, the door projection **308** (see FIG. 6) disengages from the door sensor **298** for indicating the open access door **236** to the controller **294a**. Accordingly, the controller **294a** recognizes this engagement or disengagement with the door sensor **298** and only permits the motor **300** to operate when the access door is closed. The controller **294a** may also monitor the rotation of the roller **244** by directly counting revolutions of the roller **244** or indirectly counting revolutions of the roller **244** by timing the amount that the motor **300** advanced the roller **244**. In either case, the controller **294a** correlates the number of roller **244** revolutions to the length of sheet **16** wrapped about the roller **244**. Finally, the controller **294a** may indicate the status of the sheet **16** to the operator as described below.

According to the exemplary embodiment of the invention, the drive mechanism **252** is contained entirely within the housing **214** of the sheet receiver **18**. However, in the alternative, portions of the drive mechanism **252** may be exterior of the housing **214**. The portions of the drive mechanism **252** may be similar portions of the pulling device **242** that connect, directly or indirectly, to the portions of the drive mechanisms **252** for rotating the roller **244**. An exemplary embodiment of a portion of the drive mechanism **252** exterior of the housing **214** will be described below in further detail.

FIG. 12 shows an exemplary embodiment of the sheet **16** for use with the sheet receiver **18** of FIG. 11. The sheet **16**

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includes the sheet head end **516** and an opposing sheet foot end **520**. Furthermore, the sheet longitudinal sides **512a**, **512b** and beaded edges **510a**, **510b** extend from the sheet head end **516** to the sheet foot end **520**. The sheet head end **516** also preferably includes a reinforced sheet portion **521** into which the slits **514a**, **514b** are sown. Examples of reinforced sheet portions **520** may comprise of multiple layers of material and/or additional stitching. Additionally, the sheet **16** may include a reinforced sheet portion **521** and slits **514a**, **514b** at both the head and foot ends **516**, **520** of the sheet **16**. As such, the sheet **16** is generally symmetrical and may be operatively connected to the sheet receiver **18** at either the sheet head end **516** or the sheet foot end **520**.

The sheet **16** also includes the sheet loaded indicia **518** and a sheet usage indicia **522**. In contrast to the sheet loaded indicia **518** described above, the sheet usage indicia **522** aligned with the alignment sheet indicia **144** of the mattress **14** (see FIG. 3A) indicates to the operator that a sufficient length of the sheet **16** is within the sheet receiver **18** and, thus, should be replaced with another sheet **16**. According to the exemplary embodiment, the sheet loaded indicia **518** is a green circle, and the sheet usage indicia **522** is a red octagon, similar to a traditional traffic "stop sign." The sheet **16** may also include a sheet remaining indicia (not shown) or a coded section **524**. The sheet remaining indicia may be positioned along the length of the sheet **16** and indicate to the operator the length of the sheet remaining before reaching the sheet usage indicia **522**. The coded section **524** may communicate with the sheet receiver **18** for verifying any information related to the sheet **16** and/or indicating such information to the operator. For example, the coded section **524** may communicate to the sheet receiver **18** the type of sheet, engaged attachment, length of sheet remaining, or any other relevant status information concerning the sheet **16** to the operator. The sheet **16** may also include a measured indicia **530** for communicating to the operator the amount of sheet **16** used, remaining, or the number of pulls remaining with respect to the present position of the sheet **16**. An exemplary embodiment of the measured indicia **530** indicates the number of pulls remaining via numerical indicators; however, it will be appreciated that any visual indication may be used in accordance with the invention. FIGS. 13A-15B show alternative embodiments of retainers according to the invention. In this respect, like numbers indicate like features of the retainers. FIG. 13A and FIG. 13B show a slide retainer **610** including a base piece **612** and a movable piece **614**. The movable piece **614** connects to the base piece **612** or otherwise projects from the base piece **612**. In addition, the movable piece **614** moves relative to the base piece **612** between the open position and the closed position for defining the channel **414** and retaining the sheet **16**, as described above.

More particularly, the base piece **612** and movable piece **614** each include cooperating tracks **616**. The track **616** of the movable piece **614** slides into the track **616** of the base piece **612** for connecting the base piece **612** and the movable piece **614** together. In addition, the movable piece slides along the track **616** of the base piece **614** to open and close the channel **414**, as indicated by arrow **618**. Because the movable piece **614** slides against the base piece **612**, a stopper **620** protrudes from the movable piece **614** toward the base piece **612** to engage the detent **430** and inhibit movement of the movable piece. Of course, the operator may simply snap the stopper **620** beyond the detent **430** in either direction such that the detent **430** is received in either the track **616** of the movable piece **614** or the closed channel **414**. However it will be appreciated that any base piece **612** and movable piece **614** slidably attached may open and close the channel **414** as

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described above. Accordingly, the slide retainer 610 is not intended to be limited to the exemplary embodiment described herein.

FIG. 14A and FIG. 14B show a pivot retainer 630 including a base piece 632 and a movable piece 634. The movable piece 634 connects to the base piece 632 or otherwise projects from the base piece 632. In addition, the movable piece 634 moves relative to the base piece 632 between the open position and the closed position for defining the channel 414 and retaining the sheet 16, as described above.

More particularly, the base piece 632 and movable piece 634 include a pair of holes 636 and a pair of dowels 638 respectively. The holes of the base piece 632 receive the dowels 638 of the movable piece 634 such that the movable piece 634 pivots between open and closed positions, as indicated by arrow 640. In addition, the base piece 632 includes a tab portion 642 that extends toward a collar 644 defined by an opening 646 in the movable piece 634. As the movable piece 634 pivots to the closed position, the tab portion 642 snaps against the collar 644 for holding the movable piece closed. Thereby, the operator may simply snap the tab portion 642 into the opening 646 and out of the opening 646 to respectively open or close the channel 414. However it will be appreciated that any base piece 632 and movable piece 634 pivotably attached may open and close the channel 414 as described above. Accordingly, the pivot retainer 630 is not intended to be limited to the exemplary embodiment described herein.

FIG. 15A and FIG. 15B show a clip retainer 650 including a base piece 652 and a movable piece 654. The movable piece 654 connects to the base piece 652 or otherwise projects from the base piece 652. In addition, the movable piece 654 moves relative to the base piece 652 between the open position and the closed position for defining the channel 414 and retaining the sheet 16, as described above. More particularly, the base piece 652 is generally rigid and includes the lip projection 416. The movable piece 654 is generally flexible and resiliently extends from the base piece 652 against the lip projection 416. The movable piece 654 also includes the planar portion 426 resiliently held against the lip projection 416 to define the channel 414 of the clip retainer 650 in the closed position. However, the movable piece 654 may resiliently bend toward the open channel 414 to receive the sheet 16, but resiliently bends back to again close the channel 414. As such, the operator may simply snap the beaded edge 510a of the sheet 16 into the channel 414. However it will be appreciated that any base piece 652 and movable piece 654 may resiliently bend to open and close the channel 414 as described above. Accordingly, the clip retainer 650 is not intended to be limited to the exemplary embodiment described herein.

FIGS. 16A-16C show a rigid retainer 660 having a body portion 662 and a base portion 664. The base portion 664 is generally planar and configured for attaching or welding as described herein. The body portion 662 defines a channel 666 and includes an opening 668 that extends through the body portion 662 and into the channel 666. Generally, the sheet 16 includes the beaded edge 510a, which is received within the channel 666. However, the beaded edge 510a, according to an exemplary embodiment, is generally compressible for insertion through the opening 668 and into the channel 666. In addition, the opening 668 may be tapered such that the opening 668 narrows into the channel 666. Accordingly, the beaded edge 510 and the opening 668 mate such that the insertion force needed to position the beaded edge 510a into the channel 666 is less than the removal force needed to withdraw the beaded edge 510a from the channel 666.

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With respect to FIG. 17, an alternative embodiment of a drive mechanism 670 includes an external portion 672 of the drive mechanism 670 and an internal portion 674 of the drive mechanism 670 contained within the housing 214. By splitting the drive mechanism 670 into external and internal portions 672, 674, patient care environments with multiple health care beds may purchase less external portions 672 for use with any number of internal portions 674. Specifically, the external portion 672 is hand held and includes an external motor 676 operably driven by an external controller 678. The operator may direct the external controller 678 to rotate the external motor 676 and, in turn, operate the internal portion 674 of the drive mechanism 670 as described above to pull the sheet 16. For instance, a nursing home with a plurality of health care beds 12 may reduce costs by only purchasing one external portion 672 for use with multiple health care beds equipped with a patient repositioning system 10a. In other words, FIG. 17 shows an embodiment wherein only a part of the drive mechanism 670 is contained within the housing 214. The other part may be hand held, and driven by a.c. or a battery.

According to an exemplary embodiment, the hand held external portion 672 inserts through a coupling 680 in the housing 214 for operatively connecting to the roller 244 shown in FIG. 6 and FIG. 9. Preferably, the coupling 680 also includes a key member 682 received within a key slot 684 while connected to the internal portion 674 for preventing backlash of the hand held external portion 672. For example, if the external motor 676 suddenly encounters substantial force during use, the external portion 672 may suddenly twist in hand. However, in the event that the key slot 684 receives the key member 682, the sheet receiver 18 will bear the backlash of the twisting force in hand. It will be appreciated that any portions of the drive mechanism 670 may be internal or external of the housing 214 in accordance with the invention described herein.

FIG. 18 is an alternative embodiment of a sheet receiver 18' having an optional digital and graphic display module 350. The display module 350 is positioned within the side panel 282a and operatively connected to the controller 294 (see FIG. 21) for displaying any information discussed herein that may be communicated via the controller 294 and indicated to the operator. The sheet receiver 18' also includes the enabling switch 210 and drive switch 212. According to one embodiment, the drive switch 212 may be the only input needed to operate the sheet receiver 18. Alternatively, the enabling switch 210 and the drive switch 212 inputs both are needed to operate the sheet receiver 18, either concurrently or sequentially.

Furthermore, the sheet receiver 18' includes a plurality of light emitting diodes (LEDs) acting as a power indicator 352, a leveling indicator 354, and an open access door indicator 356. The power indicator 352 emits light to indicate that the sheet receiver 16 is enabled for operation. The leveling indicator 354 emits light to indicate that the sheet receiver 18' is too unlevel for operation. The open access door indicator 356 emits light to indicate that the access door 236 is open and, as such, not ready for operation until the access door 236 is sufficiently closed.

The sheet receiver 18' also includes a sheet release 234' and a door release 358. The sheet release 234' is operatively connected to the clutch 276 (see FIG. 8) for disengagement and releasing of the sheet 16 (see FIG. 7A-7C) as described above. The door release 358 operatively slides to the right, with respect to FIG. 18, in order to release the latch 360. Specifically, as the door release 358 translates, the latch 360 rotates out of a cooperating door slot 362 within the access

door 236 for allowing the access door 236 to move as described herein. The latch 360 is biased with a torsion spring 364 for returning the latch 360 and insertion into the door slot 362. As such, the latch 360 locks the access door 236 in the closed position for preventing the taut sheet 16 similar to FIG. 3E from lifting the access door 236 open while being pulled. Furthermore, another latch (not shown) is connected to the latch 360 via the extended bar 366. In this respect, the sheet receiver 18' has two symmetrically positioned latches 360 for locking the access door 236 closed.

FIG. 20 shows another alternative sheet receiver 18" for use with a mattress 14". Notably, the sheet receiver 18" is integrated into the head deck portion 32". Accordingly, the sheet receiver 18" may be used with the mattress 14", which includes a head end section 122" with a substantially uniform thickness throughout. Furthermore, the head end section 122" is substantially the same thickness as the remainder of the mattress 14". While the exemplary embodiment of the sheet receiver 18" is integrated with the head deck portion 32", it will be appreciated that the sheet receiver 18" may alternatively be mounted below the head deck portion 32" for use with the mattress 14" of substantially uniform thickness throughout. In other respects, like numbers indicate like features described above.

With respect to FIG. 21, the controller 294 may be connected to one or more switches for preventing the patient from contacting the headboard 28 during use. According to an exemplary embodiment, a pressure pad 684 senses pressure of patient contact while a light curtain 686 senses the patient breaking the light passing therethrough. Alternatively, the controller 294 may be operatively connected to a trip switch 688 switch operably mounted to the sheet receiver 18. Similarly to the pressure pad 684, in the event that the patient passes too close the head end, the patient contacts the trip switch 688 for communicating the patient's presence to the controller 294. The controller 294 may also maintain the amount of time the sheet receiver 16 operates with an operation timer 690 and the amount of electrical current or rate of electrical current being used by the drive mechanism 252 at any given time.

In any case, the controller 294 is operatively connected to a status indicator, such as the display 350 described above with respect to FIG. 18, the drive mechanism 252, and the pulling device 242. As such, if the operation time 690 reaches a predetermined maximum amount of time, the maximum electrical currents peaks via a motor shunt control 692, or the pressure pad 684, light curtain 686, or trip switch 688 communicates with the controller 294, the controller 294 may remove power from the drive mechanism 252 to stop the patient from moving toward the headboard 28. The controller 294 may also communicate visually via the status indicator 350 or audibly via an operatively connected alarm generator 694.

Another option of an exemplary embodiment shows a sheet receiver 18 having a UV disinfection module 694 contained therein for selectively operation. Specifically, the module 694 is connected to a UV control interface that also connects to the controller 294. As such, the operator may selectively operate the UV disinfection module 694, or the controller 294 may maintain the operation time 690 for periodic disinfection.

According to another exemplary embodiment, the patient repositioning device 10 may be used as substantially described above with respect other types of beds. For example, the patient repositioning device 10 may be used with a birthing bed described within U.S. Pat. No. 6,757,924, the disclosure of which is hereby incorporated by reference herein. In this respect, the mattress is sized and shaped so as

to accommodate the removal of the foot section of the birthing bed. By way of another example, the patient repositioning device 10 may also be used with a bed described within U.S. Pat. No. 5,692,256, the disclosure of which is hereby incorporated by reference herein. In this respect, the mattress has a non-uniform thickness with respect to a central lateral vertical plane. Of course, the patient repositioning device 10 may be configured to accommodate a conventional bed or any other bed for which repositioning the patient provides increased comfort and performance to both the operator and the patient.

In use, with a patient supported on the sheet 16 and the sheet 16 located on the mattress 14, this patient repositioning system 10 enables an attendant to cause the sheet 16 and the patient supported thereon to move toward the head end 30 of the mattress 14, as the sheet 16 is pulled into the slot 216 formed in the housing 214. Because the sheet 16 has a width that is greater than that of the mattress 14, and that additional width is retained along opposing longitudinal sides of the mattress 14, as the sheet 16 moves and the patient is repositioned the outer portions of the sheet 16, i.e. the sheet longitudinal sides 412a, 512b move from a substantially vertical orientation to a substantially horizontal orientation as the sheet 16 is pulled into the slot 216. For each sheet 16, a number of such patient repositionings may occur, until the system 10 indicates via the sheet usage indicia 522 that it is time to replace the sheet 16. Generally, the attendant causes the sheet 16 to move via operation of the inputs to the drive mechanism 252, as described above.

To initiate patient repositioning using this system, an attendant places a sheet 16 on the mattress 14, connects the sheet 16 to the mattress 14, and also operatively couples the sheet 16 to the drive mechanism 252. Typically, this connecting of the sheet 16 to the mattress 14 involves securing opposite sheet longitudinal sides 512a, 512b of the sheet 16 to oppositely located rows of retainers 116 spaced along the length of the mattress 14, and the sheet 16 has beaded edges 510, 510b along its longitudinal sides 512a, 512b which allow for longitudinal movement of the sheet 16 along the retainers 116. To operatively couple the sheet 16 to the drive mechanism 252, the attendant which may also be referred to as an operator, releasably attaches the sheet 16 to the drive mechanism 252, and the drive mechanism 252 is then used to pull the sheet 16 toward the head end 30 of the mattress 14, to "load" the sheet 16 in preparation for subsequent pullings of the sheet 16 toward the head end 30 of the mattress 14 with a patient residing thereon.

In some situations, it may be necessary to replace a sheet 16 on a mattress 14 while a patient remains thereon, perhaps due to soiling of the sheet 16, or other reasons. In this situation, after removal of the old sheet 16, the attendant retains a first beaded edge 510a of a first longitudinal side 512a of the new sheet 16 to the row of spaced retainers located on one side of the mattress 14. Thereafter, the patient and the sheet 16 are maneuvered so as to place the sheet 16 between the patient and the mattress 14, and then the attendant retains the second beaded edge 510a of the opposite, second longitudinal side 510b of the new sheet 16 to the second row of spaced retainers 116 located on the second side of the mattress 14. Once the sheet 16 has been retained on both sides of the mattress 14, the sheet 16 is then releasably attached to a drive mechanism 252 located adjacent the head end 30 of the mattress 14, and the sheet 16 is thereafter pulled toward the head end 30 of the mattress 14 to "load" the system. Typically, during this initial pulling, the head end of the sheet 16 is not weight bearing, i.e., the patient is not residing thereon. Stated alternatively, the new sheet 16 is retained on the mattress 14 with some amount

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of slack at the head end **30** thereof, as indicated by indicia on the new sheet **16**, to facilitate unweighted pulling of the sheet **16** to the loaded position.

In addition to these methods as described above, this patient repositioning system **10** also facilitates infection control, or even retrieval of the sheet **16**, by facilitating access to the housing **214** into which the sheet **16** is pulled. More particularly, to access the inside of the housing **214**, the attendant merely needs to open the access door **236** to the housing **214**. There is no need to raise any portion of the bed. Depending on the configuration of the patient repositioning system **10** and the structure of the bed, this opening of the access door **236** may occur after moving the head end piece **124** of the mattress **14**, as by folding. Moreover, this opening the access door **236** may involve manipulation of the bottom of the mattress **14**, or the top of the bed deck **22**, depending on how the housing **214** is configured with respect to the mattress **14** and/or the bed deck **22**.

This specification shows and describes several preferred embodiments of the invention. However, those skilled in the art will appreciate that the disclosed embodiments are susceptible to a reasonable amount of modification and/or permutation, without departing from the overall scope of the invention. For instance, the dimensions of the components shown and described, and/or the relationships of those dimensions to other components may vary, as needed, in order to apply the general principles of the present invention to the actual circumstances at hand.

Moreover, it is to be understood that the recitation of “objects of the invention” in this specification, or references problem recognized in the prior art, are not intended to be construed as an admission that others have also recognized the same problems or perceived the same limitations in the state of the art, as recognized by the present inventors. Moreover, any reference to objects of the invention is not intended to require each of the following claims to achieve all of the above-stated objects or advantage. Rather, the recitation of the objects of the invention in this specification is intended merely to help explain the story behind the present invention, and to explain why the present invention represents an advance in the state of the art over existing technology. Accordingly, the inventors intend that the scope of the appended claims is not to be limited by the specific details shown or described in this specification.

We claim:

1. A patient repositioning system comprising:

a mattress having a head end and a foot end, and an upper surface, the mattress further having a head end piece which is defined in part by a first surface that resides in engagement with a second surface that is part of a rest of the mattress, such that the first surface and the second surface reside in engagement along a predetermined plane, the head end piece being movable relative to the rest of the mattress to an access position such that the first surface of the head end piece resides away from the predetermined plane and the second surface of the rest of the mattress;

a sheet residing on the upper surface;

a drive mechanism located below the upper surface of the head end of the mattress, the drive mechanism operatively connected to the sheet and adapted to pull the sheet and a patient residing thereon toward the head end thereby to reposition the patient; and

a housing holding the drive mechanism below the upper surface of the head end of the mattress, the housing being accessible by moving the head end piece of the mattress to the access position.

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2. The patient repositioning system of claim **1** wherein the mattress has an upper surface of substantially uniform width and length.

3. The patient repositioning system of claim **1** wherein the mattress has a head end section of reduced thickness.

4. The patient repositioning system of claim **3** wherein the head end section has a fold line along the predetermined plane and the head end piece is movable relative to the rest of the mattress by folding about the fold line.

5. The patient repositioning system of claim **1** wherein the housing further comprises:

an access door movable relative to the housing thereby to permit access to the inside of the housing.

6. The patient repositioning system of claim **5** wherein the access door is hingedly connected to the housing, thereby to provide hinged opening of the access door to enable access to the drive mechanism held therein.

7. The patient repositioning system of claim **1** wherein the head end piece of the mattress is firmer than the rest of the mattress.

8. The patient repositioning system of claim **1** wherein the housing includes an extension which limits compression of the mattress as the sheet is pulled toward the head end.

9. The patient repositioning system of claim **1** wherein the movable head end piece remains connected to the rest of the mattress when the housing is accessed.

10. The patient repositioning system of claim **1** wherein the head end of the mattress, at the upper surface thereof, has a head end edge comprising at least one of a surface of reduced elasticity, reduced friction material, and protective wear material.

11. The patient repositioning system of claim **3** wherein the mattress has a generally uniform thickness except for the head end section.

12. The patient repositioning system of claim **1** wherein the mattress has a non-uniform thickness with respect to a central lateral vertical plane.

13. The patient repositioning system of claim **1** wherein the mattress is sized and shaped so as to accommodate a conventional articulating hospital bed.

14. The patient repositioning system of claim **1** wherein the mattress has opposing vertical side walls and the system further comprises:

two rows of spaced retainers extending along the length of the mattress, each of the rows including a plurality of discretely spaced retainers located on one of the vertical side walls, and adapted to capture a corresponding side of the sheet and to retain said captured corresponding side as the sheet moves toward the head end during repositioning.

15. The patient repositioning system of claim **14** wherein the sheet has a width greater than that of the surface, so that the sheet held by the retainers extends over opposing longitudinal edges of the mattress.

16. The patient repositioning system of claim **14** wherein each of the retainers has a closed position so as to define a channel for retaining a corresponding longitudinal side of the sheet, and an open position to facilitate removal of the sheet from the channel.

17. The patient repositioning system of claim **16** wherein the retainers are welded to the mattress.

18. The patient repositioning system of claim **16** wherein the retainers have a detented orientation to affirmatively indicate when the retainer is in the closed position.

19. The patient repositioning system of claim **14** wherein the retainers are substantially inflexible and mate with a sheet with a compressible edge.

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20. The patient repositioning system of claim 14 wherein the retainers are located in positions that remain accessible when the system is used with a conventional health care bed.

21. The patient repositioning system of claim 16 wherein each of retainers has a base piece secured to the mattress and a movable piece connected to the base piece, the movable piece being movable relative to the base piece.

22. The patient repositioning system of claim 21 wherein the movable pieces rotate about an axis that is traverse to the longitudinal direction of the mattress.

23. The patient repositioning system of claim 21 wherein the movable pieces rotate about an axis that is parallel to the longitudinal direction of the mattress.

24. The patient repositioning system of claim 21 wherein the movable pieces slide in a plane parallel to the longitudinal sides of the mattress.

25. The patient repositioning system of claim 1 and further comprising:

a bed having a head end, the housing secured to the head end of the bed.

26. The patient repositioning system of claim 25 wherein the housing is at least partially below an upper surface of the head end of the bed.

27. The patient repositioning system of claim 1 further comprising:

a pulling device mounted within the housing, operatively connected to the drive mechanism and also operatively coupled to the sheet, whereby upon activation of the drive mechanism the pulling device pulls the sheet into the housing via a slot in the housing.

28. The patient repositioning system of claim 1 further comprising:

a roller mounted within the housing, operatively connected to the drive mechanism and also operatively coupled to the sheet, whereby upon activation of the drive mechanism the roller rotates to pull the sheet into the housing via a slot in the housing.

29. The patient repositioning system of claim 28 wherein the roller is releasably attached to a head end of the sheet.

30. The patient repositioning system of claim 28 wherein the roller is removable from the housing.

31. The patient repositioning system of claim 28 wherein the slot has a transverse dimension of less than about 8 mm.

32. The patient repositioning system of claim 28 wherein the housing defines at least one internal compartment, and the roller is located in the compartment and has sufficient clearance to enable cleaning and maintenance.

33. The patient repositioning system of claim 28 wherein the slot is oriented in a horizontal direction.

34. The patient repositioning system of claim 28 and further comprising:

a connecting structure having first and second ends, with the first end thereof secured to the roller and the second end thereof releasably attached to the sheet, the connecting structure being of sufficiently small dimension so as to pass through the slot.

35. The patient repositioning system of claim 34 wherein the connecting structure further comprises:

at least one strap having a first end secured to the roller and a second end with a tab located thereat, and adapted to be releasably attached to the sheet via at least one reinforced slit formed in the sheet.

36. The patient repositioning system of claim 35 wherein the tab has a T-shape.

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37. The patient repositioning system of claim 28 further comprising:

a controller operatively connected to the drive mechanism; and

a sensor for sensing and storing the number of rotations of the roller, the controller adapted to correlate said number of rotations of the roller to at least one of: the amount of sheet that is remaining to be advanced, the amount of sheet already advanced, and the positional relationship of the sheet length relative to the mattress.

38. The patient repositioning system of claim 37 and further comprising:

a display mounted on the housing and operatively connected to the controller, and adapted to convey at least one of: the amount of sheet that remains to be used, the amount of sheet already advanced, and the positional relationship of the sheet length relative to the mattress.

39. The patient repositioning system of claim 1 further comprising:

a controller operatively connected to the drive mechanism; and

a head angle elevation sensor operatively connected to the controller, and which, when activated, permits the pulling of the sheet toward the head end of the mattress.

40. The patient repositioning system of claim 1 and further comprising:

sheet usage indicia for indicating at least one of: the amount of sheet remaining to be advanced, the amount of sheet that has already advanced, and the positional relationship of the sheet length relative to the mattress.

41. The patient repositioning system of claim 1 wherein the mattress resides on a bed frame having a footboard, and further comprising:

a barrier located beyond the foot end of the mattress for supporting the sheet, the barrier connected to at least one of the mattress, the bed frame, and the footboard.

42. The patient repositioning system of claim 1 wherein the mattress resides on a bed frame having a footboard and further comprising:

a barrier connected to at least one of the mattress, the bed frame, and the footboard thereby to maintain a desired amount of spacing between the foot end of the mattress and the footboard and to enable unobstructed movement of the sheet toward the housing upon activation of the drive mechanism.

43. The patient repositioning system of claim 1 wherein the mattress resides on a bed frame having a footboard, and wherein the mattress is releasably connected to at least one of the housing and bed frame, and has a predetermined length that permits a desired amount of spacing between the foot end of the mattress and the footboard so as to enable unobstructed movement of the sheet toward the housing upon activation of the drive mechanism.

44. The patient repositioning system of claim 1 further comprising:

a controller operatively connected to the drive mechanism; the controller including at least one input that must be activated to pull the sheet toward the head end of the mattress.

45. The patient repositioning system of claim 1 wherein the drive mechanism resides entirely within the housing.

46. The patient repositioning system of claim 1 further comprising:

sheet loaded indicia located on the sheet whereby upon activation of the drive mechanism the releasably attached sheet advances into the housing via the slot until the sheet has advanced to a predetermined length,

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the sheet loaded indicia providing an indication as to when such advancement has occurred.

47. The patient repositioning system of claim 46 wherein the sheet loaded indicia is detectable in at least one of the following locations: top and bottom surfaces, left and right longitudinal edges, beginning center and end of the sheet.

48. The patient repositioning system of claim 46 further comprising:

corresponding mattress indicia located on the mattress, to enable a user to readily determine when the sheet loaded indicia is aligned with the corresponding mattress indicia, thereby to enable the determination that such wrapping has occurred.

49. The patient repositioning system of claim 1 further comprising:

a controller operatively connected to the drive mechanism; the controller including at least two inputs that must be activated to pull the sheet toward the head end of the mattress.

50. The controller of claim 49 wherein the inputs must be activated according to one of the following modes to pull the sheet toward the head end of the mattress; concurrently and sequentially.

51. A patient repositioning system comprising:

a mattress having a head end and a foot end, and an upper surface, the mattress further having a head end piece which is movable relative to the rest of the mattress;

a sheet residing on the upper surface;

a drive mechanism located below the upper surface of the head end of the mattress, the drive mechanism operatively connected to the sheet and adapted to pull the sheet toward the head end;

a housing holding the drive mechanism below the upper surface of the head end of the mattress, the housing being accessible by moving the head end piece of the mattress; and

a roller mounted within the housing, operatively connected to the drive mechanism and also operatively coupled to the sheet, whereby upon activation of the drive mechanism the roller rotates to pull the sheet into the housing via a slot in the housing wherein the sheet has a width greater than the roller and the roller has a central portion and opposing outer portions, and the outer portions have a reduced diameter to accommodate the excess width of the sheet which extends beyond the width of the roller.

52. A patient repositioning system comprising:

a mattress having a head end and a foot end, and an upper surface;

a sheet residing on the upper surface;

a drive mechanism located below the upper surface of the head end of the mattress, the drive mechanism operatively connected to the sheet and adapted to pull the sheet toward the head end with a patient residing thereon, thereby to reposition the patient; and

a housing holding the drive mechanism below the upper surface of the head end of the mattress, wherein the drive mechanism further comprises:

an arrestor adapted to normally hold the sheet in place so as to prevent movement of the sheet toward the foot end of the mattress, and operable to selectively enable the sheet to be repositioned, reversed, or removed from the housing.

53. The patient repositioning system of claim 52 wherein the arrestor is also adapted to be disengaged so as to permit sheet removal.

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54. The patient repositioning system of claim 52 wherein the arrestor comprises at least one of the following: a brake, shorted motor leads, a clutch, and high ratio gear.

55. The patient repositioning system of claim 52 wherein the mattress has a head end piece that is movable relative to the rest of the mattress, and the housing is accessible by moving the head end piece of the mattress.

56. A patient repositioning system comprising:

a mattress having a head end and a foot end and an upper surface;

a sheet residing on the upper surface;

a pulling device operatively connected to the sheet and adapted to pull the sheet toward the head end with a patient residing thereon, thereby to reposition the patient;

a housing holding the pulling device; and

a hand held device operable to actuate the pulling device from outside the housing, wherein the hand held device contains at least one of: a motor, a clutch and a gear set, and further comprising:

a controller operatively connected to the pulling device; and

a sensor operatively connected to the pulling device and to the controller, and adapted to sense and store the amount of sheet advanced by the pulling device, the controller adapted to correlate said sensed and stored amount to at least one of: the amount of sheet remaining to be advanced, the amount of sheet already advanced, and the positional relationship of the sheet length relative to the mattress.

57. A patient repositioning system comprising:

a mattress having a head end and a foot end, and an upper surface;

a sheet residing on the upper surface;

a drive mechanism, the drive mechanism operatively connected to the sheet and adapted to pull the sheet toward the head end with a patient residing thereon, thereby to reposition the patient; and

a housing holding at least a part of the drive mechanism, the housing containing an access door, the access door providing access to an inside of the housing,

wherein the mattress has opposing vertical side walls and the system further comprises:

two rows of spaced retainers extending along the length of the mattress, each of the rows including a plurality of discretely spaced retainers located on one of the vertical side walls and adapted to capture a corresponding side of the sheet and to retain said captured corresponding side as the sheet moves toward the head end during repositioning.

58. A patient repositioning system comprising:

a mattress having a head end and a foot end, and an upper surface, the mattress further having a head end piece which is movable relative to the rest of the mattress;

a sheet residing on the upper surface;

a drive mechanism located below the upper surface of the head end of the mattress, the drive mechanism operatively connected to the sheet and adapted to pull the sheet toward the head end; and

a housing holding the drive mechanism below the upper surface of the head end of the mattress, the housing being accessible by moving the head end piece of the mattress, whereby upon deactivation of the drive mechanism, after having pulled the sheet toward the head end of the mattress, the drive mechanism reverses to reduce the tightness in the sheet at the head end of the mattress.

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- 59.** A patient repositioning system comprising:
- a mattress having a head end and a foot end, and an upper surface, the mattress further having a head end piece that is movable relative to the rest of the mattress to an access position; 5
 - a sheet residing on the upper surface;
 - a drive mechanism located below the upper surface of the head end of the mattress, the drive mechanism operatively connected to the sheet and adapted to pull the sheet toward the head end with a patient residing thereon 10 to thereby reposition the patient; and
 - a housing holding the drive mechanism below the upper surface of the head end of the mattress, the housing being accessible by moving the head end piece of the mattress to the access position, the housing further 15 including an access door movable relative to the housing to an open position to permit access to the inside of the housing, the access door being located below the head end piece, whereby movement of the head end piece to the access position and movement of the access door to 20 the open position provides access to the inside of the housing, thereby to facilitate cleaning of the housing.
- 60.** The patient repositioning system of claim **59** wherein the mattress has a head end section of reduced thickness, the head end section has a fold line and the head end piece is 25 movable relative to the rest of the mattress by folding about the fold line; and the access door is defined by a plurality of sides, with at least one of the sides being substantially parallel to the fold line.
- 61.** A patient repositioning system comprising: 30
- a mattress having a head end and a foot end, an upper surface, and opposing vertical side walls;
 - a sheet residing on the upper surface;

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- a drive mechanism located below the upper surface of the head end of the mattress, the drive mechanism operatively connected to the sheet and adapted to pull the sheet toward the head end to thereby reposition a patient residing thereon;
 - a housing holding the drive mechanism below the upper surface of the head end of the mattress; and
 - two rows of spaced retainers extending along the length of the mattress, each of the rows including a plurality of discretely spaced retainers located on one of the vertical side walls, and adapted to capture a corresponding side of the sheet and to retain said captured corresponding side as the sheet moves toward the head end during repositioning.
- 62.** A patient repositioning system comprising:
- a mattress having a head end and a foot end and an upper surface;
 - a sheet residing on the upper surface;
 - a pulling device operatively connected to the sheet and adapted to pull the sheet toward the head end with a patient residing thereon, thereby to reposition the patient;
 - a housing holding the pulling device; and
 - a sensor operatively connected to the pulling device and to the controller, and adapted to sense and store the amount of sheet advanced by the pulling device, the controller adapted to correlate said sensed and stored amount to at least one of: the amount of sheet remaining to be advanced, the amount of sheet already advanced, and the positional relationship of the sheet length relative to the mattress.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 9,205,012 B2
APPLICATION NO. : 13/837185
DATED : December 8, 2015
INVENTOR(S) : William A. Hillenbrand, II et al.

Page 1 of 2

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the Specification:

At column 1, line approx. 4, "... patient repositioning, and more particularly, to a safe, ..." should read --... patient repositioning and, more particularly, to a safe ...--.

At column 2, line approx. 15, "This system and method also facilitates ..." should read --This system and method also facilitate ...--.

At column 2, line approx. 17-18, "In fact, this system and method eliminates ..." should read --In fact, this system and method eliminate ...--.

At column 4, line approx. 52, "...this system and method provides a ..." should read --... this system and method provide a ...--.

At column 5, line approx. 36, "To achieve this contoured affect, the ..." should read --To achieve this contoured effect, the ...--.

At column 6, line approx. 27, "The system and method disclosed herein is not limited to ..." should read --The system and method disclosed herein are not limited to ...--.

At column 8, line approx. 39-40, "each of the ... are ..." should read --Each of the ... is ...--.

At column 13, line approx. 19, "... is not intended to be limited these exemplary ..." should read --... is not intended to be limited to these exemplary ...--.

At column 13, line approx. 50-51, "... includes a portion of the sheet receiver 18 that may that interact with the ..." should read --... includes a portion of the sheet receiver 18 that may interact with the ...--.

At column 16, line 1, "Furthermore, term "low-profile" with ..." should read --Furthermore, the term "low-profile" with ...--.

At column 16, line approx. 9, "... tends create ..." should read --... tends to create ...--.

Signed and Sealed this
Twenty-first Day of June, 2016



Michelle K. Lee
Director of the United States Patent and Trademark Office

In the Specification:

At column 16, line approx. 32, "... for the predetermined period of time/" should read --... for the predetermined period of time.--.

At column 18, line approx. 7, "... may comprise of multiple layers of ..." should read --... may comprise multiple layers of ...--.

At column 18, line approx. 35, "The sheet 16 may also includes a ..." should read --The sheet 16 may also include a ...--.

At column 21, line approx. 31-32, "... connected to a trip switch 688 switch operably mounted to ..." should read --... connected to a trip switch 688 operably mounted to ...--.

At column 21, line approx. 55-56, "... module 694 contained therein for selectively operation." should read --... module 694 contained therein for selective operation.--.

At column 21, line approx. 63, "... described above with respect other types ..." should read --... described above with respect to other types ...--.

At column 22, line approx. 41, "... the attendant which may also be referred to as an operator, ..." should read --... the attendant who may also be referred to as an operator, ...--.

At column 23, line approx. 30-31, "... or references problem recognized in ..." should read --... or references to problems recognized in ...--.

In the Claims:

At column 25, claim number 21 line number 5 [17] "... each of retainers has a base ..." should read --... each of the retainers has a base ...--.